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THE UNIVERSITY OF ALBERTA

A STUDY OF THE DEVELOPMENT
OF THE SECONDARY SCHOOL
PHYSICAL SCIENCE PROGRAM IN ALBERTA

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "A Study of the Development of the Secondary School Physical Science Program in Alberta", submitted by Walter Leslie Hughes in partial fulfilment of the requirements for the degree of Master of Education.

May, 1964

ABSTRACT

In this study an attempt has been made to describe the Alberta High School Physical Science program, as it has evolved from 1889 to 1952. An effort has been made to: delineate its historical background; to identify the content of the various courses which have comprised the program; to outline the major revisions to the physical science curriculum; and, to determine some of the significant factors which have affected its evolution.

Because the secondary school system adopted by the North West Territories was patterned after Ontario's, a brief outline of the development of physical science programs in Upper Canada and early Ontario has been included. Significant developments regarding programs of study, courses and course content are discussed in chronological order. The data were gathered from many sources: official documents and reports, courses of study, curriculum guides, course outlines, textbooks, Departmental Examinations and historical references.

Revisions were found to be generally of a minor nature involving the addition of a few new topics, the selection of a new textbook and the re-emphasis of the importance of sound methodology in the attainment of the objectives of science teaching. A disparity between frontier knowledge in science and the content of courses in high school has resulted from infrequent and relatively insignificant revisions to the physical science curriculum.

A number of factors were found to have exerted a significant influence on the evolution of the physical science program. Included among these were the accepted purposes of secondary education, changing economic and social conditions, changes in the nature and size of the high school population, teacher qualifications and supply, the University, Departmental Examinations, organization and size of schools and school districts, physical science curricula developed elsewhere, major economic depressions, the World Wars, the inertia of

tradition and more recently, the technological revolution, and the "explosion" of knowledge in science.

Certain of these factors have tended to promote curriculum revision and experimentation with new approaches in science education, while the influence of others has tended to impede progress and maintain the status quo.

The most pervasive feature throughout the various high school physical science curricula in Alberta was found to be a preoccupation with content. Insufficient emphasis and attention has been given to the development and utilization of methods of science education which would facilitate understanding of the processes of science and the unique attributes of scientists. It would appear that for revisions to be significant and for instruction to be improved, the broader and more comprehensive objectives of science education must be taken into account.

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CHAPTER I

INTRODUCTION

I. ORIGIN, PURPOSE AND NEED OF THE STUDY

During almost three quarters of a century of growth and development, the organization of Alberta's secondary schools and the prescribed programs of studies for pupils attending them have undergone a number of modifications and revisions. Throughout this period, physical science has constituted one of the major areas of study in these schools and, as such, has been subjected to changes along with other elements of the program. Greater understanding of the position accorded to physical science in today's curriculum and more intelligent planning of future modifications to the study of this discipline may result from a knowledge of how it has evolved in Alberta's high schools. Best contends that the purpose of investigations into the past is to discover generalizations which can assist in the understanding of present problems and in preparing for the future. He states that, "The focus of historical research is change, growth of development of individuals, groups, practices, movements, institutions or ideas."¹ Would it not seem, therefore, that some connected account of the origin and progress of the Alberta Physical Science Program should be written?

Radomsky, who made a comparative study of the high school programs in physics and chemistry for the years 1935 - 1936 and 1959 - 1960, suggested that a study of the history of changes in the physical science curriculum in

¹Best, J. W., Research in Education. (New York: Prentice Hall, Inc., 1959), p. 12.

Alberta might prove useful.² The present study is directed toward this end and it is hoped that, within the limits set forth, it provides educators with a reasonably complete and accurate record of the origin and development of the Alberta Secondary School Physical Science Program from 1889 to 1952.

II. THE PROBLEM

The problem may be defined as an attempt to describe, as accurately as possible, the Alberta Secondary School Physical Science Program, as it has evolved to 1952. An effort has been made to:

- 1) survey briefly the historical background against which the program was initiated;
- 2) identify the content of the program as it has existed at various stages;
- 3) outline the major revisions and changes in emphasis during the period of this study;
- 4) determine some of the major factors which appear to have affected the development of the program.

III. SOURCES OF INFORMATION

Specific information regarding the physical science programs followed in Alberta high schools was generally difficult to locate. An organized and complete collection of records of developments in the field of education in Alberta, especially in such areas as testing, programs of study, and textbooks, is simply non-existent.

Numerous sources, both primary and secondary, were used in the gathering of information for this study.

²Radomsky, Steve W., "A Comparative Study of the High School Physical Science Programs for the Two School Years 1935-36 and 1959-60", (Unpublished Master's Thesis, University of Alberta, Edmonton, 1961), p. 66.

Primary sources were used almost exclusively in the main body of this thesis and the most useful of these are discussed briefly below. The use of secondary sources was confined chiefly to the introduction to this work where limitations on the availability of materials made the procuring of original documents impractical.

During the Territorial period, educational affairs were administered by the Board of Education, by the Council of Public Instruction, and finally, by the Department of Education. Subsequent to formation of the Province of Alberta in 1905, educational matters have been under the jurisdiction of the Department of Education. The reports of these various administrative agencies, in the form of printed materials and microfilms, were found to be extremely useful. This was the case especially in the period prior to 1923 when the printing of Courses of Studies or Curriculum Guides was apparently not a common practice. For the period 1889 to 1914 these reports provided the names of the prescribed textbooks, copies of examination papers and sometimes brief indications of the scope of the courses studied. The reports contained, also, certain official policy statements and reports of officials which provided further information about such aspects as facilities and equipment, organization of classes, methods of teaching and studying, and opinions on the effectiveness of the science program as it existed at the time.

The most useful indicators of the specific content of science courses, especially in the period prior to 1923, were the prescribed textbooks. It was not possible to locate copies of all of these. However, a number of the texts used in Alberta high schools during the period under study were obtained from various universities across Canada through the Inter-Library Loan Service. Others were

acquired from the Correspondence School Library, from the School Book Branch, from the Superintendents' Library of the Department of Education, and from various individuals who lent their personal copies of early textbooks. Another useful source of information regarding the science courses at this time was the examination papers, copies of which were appended to the reports of the Council of Public Instruction, the Board of Education and the Department of Education. During this period, course outlines, where they existed at all, were very skeletal and often consisted of no more than a naming of the prescribed text or a listing of certain of its chapters.

From 1912 on, and particularly since the early 1920's when curriculum revision came to be more of a committee process, the reports of various committees and subcommittees of the Department of Education, which were concerned with program re-organization and revision at the secondary school level, were the prime indicators of the reasons for revisions.

Other publications such as the High School Handbook, the Official Bulletin of the Department of Education, Course Outlines and, of course, the Curriculum Guides, contain detailed information about the content of various courses in science.

Newspapers published in Edmonton in the early part of the period are now on microfilm in the Provincial Library, Legislative Buildings, Edmonton. While these report on various aspects of education, they were found to be more useful generally in terms of background material and general reference to program changes, than in terms of specific information relating to the subject of physical science.

IV. THE LIMITATIONS OF THE STUDY

The present investigation has been limited to the physical science programs in the secondary schools. For purposes of this study the term secondary school has been used to refer to that institution or system of education in which the pupil spends the last three or four years prior to graduation. Normally it encompasses the age group from fourteen to eighteen years. Between 1889 and 1912 this included standards VI, VII and VIII; from 1912 to 1937 it comprised grades IX to XII inclusive; from 1937, when grade IX was transferred to the intermediate or junior high school, until 1952, this study is concerned only with grades X, XI and XII.

The term physical science has been applied in textbooks and other references in the following ways: to physics alone; to physics and chemistry; or to physics, chemistry, astronomy, geology and meteorology collectively. In the present work it has been used to mean physics and chemistry. Courses entitled Science or General Science have appeared at various times on the high school program. These have received consideration only when they have been comprised largely of units that are essentially non-biological in nature, with minor emphasis on astronomy or geology and consisting, for the most part, of topics which might well form part of a beginning course in chemistry or physics. A more comprehensive study would necessarily include the other branches of physical science which have, occasionally, formed part of the Alberta high school program.

Finally, this study has excluded the early church schools, programs of special schools such as agricultural schools, commercial schools and technical schools, and has been confined to those schools commonly known as secondary schools under the control of the Alberta Department of Education or its predecessors.

V. RELATED STUDIES

Previous theses concerning the secondary school system in Alberta which were found helpful in the present study include those by Aylesworth,³ Goresky,⁴ Walker⁵ and Radomsky.⁶ Although the first three are historical in nature, none deals specifically with the history of a particular subject or area of study such as physical science. Radomsky's thesis, while concerned with physical science, is a comparative study. Because he found the physical science programs for 1935-36 and 1959-60 to be remarkably similar, Radomsky recommended an historical study as a worthwhile follow-up to his investigations.

³Aylesworth, N. M., "A History of the High School Courses of Study for Alberta." (Unpublished Master's Thesis, The University of Alberta, Edmonton, 1936).

⁴Goresky, Isidore, "The Beginning and Growth of the Alberta School System." (Unpublished Master's Thesis, The University of Alberta, Edmonton, 1944).

⁵Walker, B. E., "Public Secondary Education in Alberta: Organization and Curriculum 1891 - 1951", (Unpublished Doctoral Dissertation, Stanford University, 1955).

⁶Radomsky, Steve W., op. cit., p. 2.

CHAPTER II

HISTORICAL BACKGROUND

In developing a background perspective for this study it was considered useful to investigate the struggle experienced by advocates of science teaching for a place for physical science in the regular high school program. After tracing the beginning of the teaching of physical science in public secondary schools, the writer has outlined briefly the development of the Ontario program in the period preceding the opening of Territorial high schools. It is hoped that this will provide some indication of the philosophical reasoning underlying early science education at the high school level in Canada, and the scope and sequence of physical science in Ontario at the time that high schools were first opened in Alberta.

I. THE BEGINNING OF SCIENCE EDUCATION IN PUBLIC SECONDARY SCHOOLS

The general study of physical science, or natural philosophy as it was then known, began in the Prussian, French and British schools around the middle of the nineteenth century.¹ The laboratory method was introduced in England in 1847 and in America in 1865. Although natural philosophy had always been on a list of subjects taught in American academies, it had, until then, been presented from the informational point of view.

II. PHYSICAL SCIENCE EDUCATION IN UPPER CANADA (ONTARIO)

In this survey of the background of physical science education, attention has been centered around the Upper

¹Monroe, Paul (editor), A Cyclopedia of Education. (New York: The Macmillan Company, 1911). Vol. I, p. 588.

Canada (Ontario) school system. The following reasons may be cited for this:

1) Many of the problems confronting Albertans, as they sought to establish a system of secondary schools were similar to those which had concerned the settlers in Ontario a few years earlier.

2) Egerton Ryerson, first Superintendent of Schools for Ontario, was an advocate of the inclusion of physical science in the secondary school program and has exerted a far-reaching influence on Canadian education.

3) Ontario contributed a number of settlers to the Territories including teachers and educators, one of the most notable being Dr. D. J. Goggin, first Superintendent of Education for the North West Territories.

4) The Ontario system of school organization and curriculum has been described as the model after which the early Territorial school system in Western Canada was fashioned.²

The Controversy over the Merits of Science Education.

In the schools of Upper Canada, very little had been done toward making the study of physical science an integral part of the secondary school program even as late as Confederation in 1867.³ The concept prevailed that the essentials of a basic education consisted of Reading, Writing and Arithmetic and that the desirable form of a higher education was based on the Classics. Population was sparse and significant industrial development lacking.

²Aylesworth, N. M., "A History of the High School Courses of Study for Alberta". (Unpublished Master's Thesis, University of Alberta, Edmonton, 1936). p. 11.

³Bell, Walter N., The Development of the Ontario High School. (Toronto: University of Toronto Press, 1918). p. 101.

Pioneer conditions prevailed; people were preoccupied with the basic struggle of winning the country from nature, and consequently, other matters received secondary consideration. Under these conditions, revisions to the high school curriculum, involving the introduction of new subjects requiring special considerations in equipment and facilities did not receive immediate approval.

Physical science edged its way into the more classical program of the day bolstered chiefly by pressures created by the great Industrial Revolution then sweeping the world.⁴ Certainly, it was not unanimously agreed that a study of science contributed to mental growth and development. Those opposing the teaching of science argued that a scientific fact is sterile, that it fails to germinate and thus contributes nothing to the training of the mind. The proponents contended that the fault lay with the method of teaching the subject rather than with science education itself. Their sentiments were ably summed up by High School Inspector G. P. Young who wrote as follows:

...Scientific instruction to be of value must be given in a certain way. To make pupils commit physical facts to memory from a book or (more frightfully still) to set them to solve questions mechanically from formulae, the mode of investigation of which they do not know--is not merely useless in an educational point of view; it is positively hurtful...The two advantages arising from scientific instruction are first the habit of intelligent observation; and second, familiarity with the inductive method of discovering truth. Science lessons to be of value must be actual exercises in induction. The teacher must make the pupils climb to the law, through all the requisite steps, by the use of his own eyes and hands... Let the pupils be told nothing, but let them be induced and guided to reason out the result for

⁴Ibid.

themselves. It is absurd to say that lessons in science thus conducted can be without power, or that they can fail to germinate...⁵

Not only was there disagreement between those favoring a literary education and those who sought to have science studies included in the curriculum, but there was also a lack of consensus among the members of this latter group. Here the chief point of contention centered around the approach to the subject.

One faction seemingly favored a program of limited scope involving the laboratory approach and a more rigorous treatment of the topics covered. Inspector Young, who was prominent among this group, expressed his concept of the importance of method and the proper scope of science studies in the high school in these words:

To secure the essential benefits of scientific instruction as these have been set forth, it is obviously not at all requisite that an extensive scientific curriculum be gone over. The grand educational advantage of scientific instruction may be in comparative measure, secured by a system of brief lessons on very limited portions of the field of science, provided that the pupils be made to go through a process of strict philosophizing within the range to which their efforts are directed. ...Thus in a brief space of time, the pupil might obtain, not a vague and uncertain glimpse, but a rigid knowledge, of limited portions of a variety of fields in the domain of science, and be prepared for prosecuting future researches in any of these fields which the circumstances of his life or the bent of his genius might incline him.⁶

The second group, advocating the inclusion of science studies in the secondary schools, favored a broader program, approached from an informational point of view. The

⁵Young, G. P., (as cited by Bell, Walter N., The Development of the Ontario High School. (Toronto: University of Toronto Press, 1918). p. 102.)

⁶Ibid., p. 103.

emphasis was to be placed on the acquisition of a wide knowledge of facts. One reason offered by this group for their support of science studies in the curriculum was the utilitarian or practical values inherent in such knowledge. The second reason involved the theory of formal discipline and transfer of training. Foremost among this group was Egerton Ryerson, Superintendent of Education for Upper Canada. On the practical values of a study of physical science, then referred to as natural philosophy, Ryerson had this to say:

In a system of practical education then, these departments of Natural Philosophy ought not to be overlooked. Their value upon the three great branches of industry--agriculture, commerce, and the mechanic arts--cannot be over-rated. They make known the sources of wealth and the best means of attaining it; they point out the surrounding dangers and suggest the remedies against them...⁷

With respect to the contribution which studies in physical science could make to the development and training of the intellect, Ryerson wrote as follows:

It has been disputed whether the primary object of Education is to discipline and develop the powers of the soul, or to communicate knowledge. Were those two objects distinct and independent, it is not to be questioned, that the first is unspeakably more important than the second; but in truth they are inseparable. That training which best disciplines and unfolds the faculties will, at the same time impart the greatest amount of real and effective knowledge; while on the other hand that which imparts thoroughly and for permanent use and possession, the greatest amount of knowledge, will best develop, strengthen and refine the powers.⁸

⁷Ryerson, Egerton (As cited by Hodgins, J. G., Documentary History of Education in Upper Canada (Ontario). (Toronto: Warwick Bros. and Rutter, 1893 - 1904), pp. 190 - 191).

⁸Ibid., p. 160.

This latter approach to the study of science did not preclude laboratory work and experimentation by students. These were considered as desirable methods of study. However, the emphasis was to be on the knowledge gained, whereas the former approach, as advocated by Inspector Young, emphasized the acquisition of a scientific method of attacking problems and finding their solutions.

The foregoing discussion has attempted to show briefly the viewpoints regarding the purposes and values of science education that were held by prominent Canadian educators during the second half of the nineteenth century, just prior to the time when high schools made their appearance in the North West Territories in 1889.

The Ontario Program 1855 - 1889

Tables I, II and III, pages 13, 14 and 15 (which were compiled from Bell), show the major revisions to the physical science programs in Ontario high schools between 1855 and the opening of Territorial high schools in 1889.⁹ Examination of these tables indicates that physical science was slowly gaining an increasingly prominent position in the Ontario curriculum. They reveal also a broadening of the scope of the courses in chemistry and physics and a growing tendency on the part of school authorities to outline the content of these courses.

The reports of the high school inspectors during this period indicate the study of science had progressed from a point where it consisted chiefly of material used to improve the reading ability of pupils, to a position as an option in the prescribed programs of both divisions of

⁹Bell, Walter N., The Development of the Ontario High School. (Toronto: University of Toronto Press, 1918), pp. 84 - 87 and 130 - 133.

TABLE I
 PARTIAL PROGRAM OF STUDIES
 FOR THE GRAMMAR SCHOOLS OF UPPER CANADA,
 SHOWING THE PRESCRIBED COURSES IN SCIENCE
 1855 and 1865

CLASS	1855	1865
FIRST (lowest)	No science	No science
SECOND	Elements of natural history as far as contained in the Third and Fourth National Readers	No science
THIRD	Elements of natural philosophy and geology as contained in the Fifth National Reader	Elements of natural history
FOURTH	Physiology as contained in the Fifth National Reader. Elements of chemistry.	Elements of natural philosophy and geology
FIFTH	Previous subjects reviewed	Elements of physiology and chemistry

TABLE II

AN EXCERPT FROM THE ENGLISH PROGRAM, 1871

SUBJECT	FIRST	SECOND	THIRD	FOURTH
NATURAL PHILOS- OPHY	Nature and use of the mechanical powers	Composition and resolu- tion of forces; center of gravity; moments of force; principle of virtual velocities and hydro- statics (Tomlinson)	Pneumatics and dynamics	Elements of elec- tricity and mag- netism
CHEMISTRY AND AGRI- CULTURE	Ryerson's Agricul- ture	Ryerson's text book completed	Elements of chemistry	Elements of chem- istry
NATURAL HISTORY	How plants grow	Animal kingdom	General review	--

TABLE III

A TABLE OF THE PHYSICAL SCIENCES,
ONTARIO HIGH SCHOOLS, 1875

LOWER SCHOOL	UPPER SCHOOL
<p>PHYSICAL SCIENCE*</p> <p>(1) CHEMISTRY: A course of experiments to illustrate the nature of fire, air, water and such solid substances as limestone and blue vitriol; hydrogen, oxygen, nitrogen, carbon, chlorine, sulphur, phosphorus and their more important compounds; combining proportions by weight and volume; symbols and nomenclature.</p> <p>(2) NATURAL PHILOSOPHY: Composition and resolution of forces; principle of moments, center of gravity; mechanical powers; ratio of the power to the weight in each case; pressure of liquids; specific gravity and modes of determining it; the barometer, siphon, common pump, forcing pump and air pump.</p>	<p>PHYSICAL SCIENCE**</p> <p>(a) CHEMISTRY: Heat--its sources; Expansion, thermometers--relations between different scales in common use; difference between temperature and quality of heat; specific and latent heat; calorimeters; liquifaction; ebullition; evaporation; conduction, convection, radiation. The chief physical and chemical characters, the preparation and the characteristic tests of oxygen, hydrogen, carbon, nitrogen, chlorine, bromine, iodine, fluorine, sulphur, phosphorus and silicon.</p> <p>Carbonic acid, carbonic oxide, oxide and acids of nitrogen, olefiant gas, marsh gas, sulfurous and sulphuric acids, sulphuretted hydrogen, hydrochloric acid, phosphoric acid, phosphuretted hydrogen, silica.</p> <p>Combining proportions by weight and by volume; general nature of acids, bases and salts; symbols and nomenclature.</p> <p>The atmosphere--its constitution, effects of animal and vegetable life upon its composition; combustion; structure and properties of flame; nature and composition of ordinary fuel.</p>

*An option between
(1) Latin, (2) French,
(3) German and
(4) Physical Science.
Chemistry and book-
keeping was permitted.

**Physical Science was not necessarily compulsory because candidates preparing for any examination were required to take only the subjects required for such examination.

the high school.¹⁰ These same reports indicate that the inspectors were most dissatisfied with the approach to the study of science which they felt was based too little upon the experimental study of important principles and too much on the rote memorization of factual material from textbooks.

Such was the position of physical science in the school system from which the Territories was to borrow considerably in professional personnel, textbooks, curricula, methods of instruction and ideas for the organization of their secondary schools.

¹⁰Ibid., p. 126.

CHAPTER III

PHYSICAL SCIENCE AND THE HIGH SCHOOLS IN THE NORTH WEST TERRITORIES 1886 - 1890

This chapter is concerned with the establishment of the high schools in the North West Territories; the division of responsibility in matters of curricula, textbooks and laboratory equipment between the central authority and local school boards; the purpose to be served by secondary schools; the first program in physical science; the first revision to this program; and a brief discussion of one of the early textbooks in physics.

I. THE ESTABLISHMENT OF UNION SCHOOLS

In his report for 1886, Thomas Grover, Inspector of Protestant schools in Western Assiniboia, urged that the Territorial Board of Education make a request to the Dominion Government for a fund to establish one or more high schools, with training schools for teachers attached. At this time, however, there was friction between the Territorial Assembly and the Dominion Government, particularly over the matter of finances. The senior government did not allow the North West Territories much authority for collecting taxes and no grant was forthcoming.¹ Thus, a narrow tax base and limited financial resources beset the Territorial schools from their beginning.

In 1889, School Ordinances of the Territories were revised to permit the establishment of Union Schools, and the first of these schools were opened at Calgary and Regina in that year.² Under provisional regulations adopted

¹Burt, A. L., The Romance of the Prairie Provinces. (Toronto: W. J. Gage and Company, 1948), p. 249.

²Report of the Board of Education, North West Territories, 1889, pp. 4 - 8.

by the Board, the trustees of each school district were charged with the responsibility of providing the necessary books and apparatus. The Board of Education prescribed the program of studies, textbooks and equipment for both the high school standards and the programs leading to the various classes of teachers' certificates. The first high school standard did not include any physical science, nor was it included on the Entrance Examination from the public schools into the high schools. However, included in the lists of high school materials for 1889 were Roscoe's Chemistry, and also the necessary apparatus for teaching botany, chemistry and physics.

II. FACTORS INFLUENCING THE FIRST PROGRAM OF STUDIES

The urgent need for teachers at this time appears to have influenced the program in the Union Schools to such a degree that the Board deemed it necessary to pass the following resolution:

Resolved: That whereas complaints have been made that too much time is devoted in Union Schools to the training of teachers, the Secretary is directed to issue a circular letter to the Principals of the various Union Schools pointing out that the primary object of the High School Department is to afford instruction in the higher branches of Education; and that the training of teachers is not part of the work of any Union School, until a Normal Department is authorized.³

This directive indicates that the official purpose of secondary schools was considered to be the provision of a higher level of general education. Despite this official edict the pressing demand in the Territories continued to be the need for teachers, and this seems to have been the major factor in determining the practices in the secondary schools. There was no university in the Territories,

³Report of the Board of Education, North West Territories, 1897, p. 7.

and no significant pressures for a matriculation program existed. This was not surprising in the light of existing conditions. Chemical industries and manufacturing in Canada were in their infancy, and consequently did not yet create a demand for matriculants from the high schools.⁴ The total high school population in the Territories was small, and the number desiring to qualify for university entrance smaller still. The universities of Manitoba and Toronto, which were the two most popular institutions of higher learning attended by students from the Territories, set their own entrance examinations. With respect to the small group of graduates seeking to proceed to university, the early Territorial high schools seem to have provided two services. First, they offered, on an elective basis, those courses in physical science and foreign languages which were required of students wishing to write university entrance examinations; and second, they administered these entrance examinations to students wishing to write them. These physical science courses also constituted a part of the non-professional program required by those seeking teachers' certificates.

III. THE FIRST PROGRAM

The inspectors employed by the Territorial Board set the examinations in chemistry and physics for prospective teachers. These papers give some indication of the program in the courses at the time and therefore, representative copies of the 1888 papers in chemistry and physics have been included in Appendices A and B, pages 152 and 165, respectively. The questions on these papers show that topics covered were similar to those in the Ontario program for 1875 (Table III, page 15). The chemistry paper for the

⁴Tory, H. M. (editor), A History of Science in Canada. (Toronto: The Ryerson Press, 1939), p. 27.

second class certificate, which was combined with the paper in botany, consisted of five essay type questions. There were no choices provided among the questions and no questions requiring the description of an experiment by the candidates. The questions on such topics as combustion, fermentation, the candle flame, water, hydrogen, chemical action, metals and non-metals, and the chemical composition of air, indicate that this course was of a very elementary nature. The other papers each consisted of three sections entitled Statics, Hydrostatics and Physics respectively. These were considered different subjects at the time, although they later became known as Physics. The questions indicate that the areas covered were: force, equilibrium, simple machines, liquids and liquid pressure, capillarity, atmospheric pressure, thermometry, heat, light, sound and electricity. The treatment of the last four topics, which later comprised major areas of physics at the secondary school level, was very elementary at this time.

IV. THE FIRST REVISION, 1890

The organization of high schools under the Territorial Board of Education in 1889 was followed by a revision in the program for these schools in 1890.⁵ The revision seems to have embodied improvements in the physical science program as revealed by the 1890 and 1891 June examinations for First Class Certificates, particularly in the physics and chemistry sections of the 1891 papers. The physics examination has questions on the telephone, the molecular and atomic concepts of matter and spectrum analysis. The appearance of such questions at this time indicates that the Board of Education was endeavoring to interject some consideration of more recent developments in physics into the curriculum.

⁵Report of the Board of Education, North West Territories, 1890, p. 6.

The questions in chemistry show increasing emphasis on some of the more useful chemical compounds. That very little teaching of the physical sciences was, as yet, taking place in the newly established high schools is revealed by examination of the inspectors' reports. These show that only in the Calgary school was any chemistry being taught in 1890 and 1891, and that to just one pupil.⁶

Under the revised program of studies for 1890 a reference was made, in the list of subjects for Standard VI, to "Theoretical Chemistry", but no other details of the course were given.⁷ The list of authorized texts for the Protestant section of the Board of Education included Roscoe's Elementary Chemistry; Knight's High School Chemistry; Kirkland's Elementary Statics; Hamblin Smith's Elementary Hydrostatics and Balfour Stewart's Elementary Physics (Primer); Balfour Stewart on Heat, and so on.

V. DR. STEWART'S TEXTBOOK IN PHYSICS

Nature and Organization of the Text

The first prescribed textbook in physics used in Territorial Schools was written by Dr. Balfour Stewart. Although this book was not available, a copy of the fourth revision, published in 1895 and containing the preface to each of the earlier editions, has been preserved in the University Library in Saskatoon. It was probably the third edition, published in June 1888, that was first prescribed for the Territorial High Schools.

⁶Annual Report of the Board of Education, North West Territories, 1891, pp. 188 - 189.

⁷Report of the Board of Education, North West Territories, 1890, p. 17.

The following quotation from the preface to his first edition of 1870 indicates something of Dr. Stewart's concept of the science of physics:

An account of the various active agents, heat, light, electricity, etc., must always form a large portion of the work in Physics. These have been regarded as varieties of energy--the laws of energy forming, as it were, the thread upon which the various divisions of the subject are strung together. The description of these agents is not, of course, materially different from that usually given; but by this means of connecting them together, the student is constantly reminded of the paramount importance of the laws of energy.

By the third edition of 1888, new material had been added to the 1870 section on sound, the 1885 section on applications of electricity, and the 1888 sections on electricity and magnetism.

The 1895 textbook was comprised of eleven chapters covering the following topics:

- 1) Laws of motion;
- 2) The forces of nature;
- 3) Energy;
- 4) Molar energy and its transmutations;
- 5) Sound;
- 6) Heat;
- 7) Radiant energy;
- 8) Electrical separation;
- 9) Magnetism;
- 10) Electricity in motion; and
- 11) Energy of chemical separation.

The treatment of the subject was chiefly qualitative rather than quantitative. Questions and a limited number of problems were included in the context appearing at the end

⁸ Stewart, Balfour, Lessons in Elementary Physics (New and Enlarged Edition). (London and New York: Macmillan and Company, 1895), pp. v - vi.

of the section rather than at the end of a lesson, or chapter. The answers to problems were given immediately following the question, probably because there were so few that a separate section at the end of the text was considered unnecessary. The explanations of various laws and phenomena were usually made by describing a suitable experiment. At first this might seem to indicate a shift towards the experimental method. However, the descriptions of the experiments were invariably accompanied by statements giving the observations and conclusions. Thus a student need not have performed, nor even have been demonstrated, any of the experiments, but need only have diligently memorized his textbook in preparation for examinations. The approach continued to be essentially informational with emphasis on rote learning of numerous facts. A few of the topics as described and discussed by Stewart are included here to give some indication of how these concepts were presented to students.

Selected Topics

In discussing aggregations of matter in the introduction of his book, Stewart depicted a whole range of sizes from the galaxies of heavenly bodies to molecules and atoms which he said "...we do not consider to be capable of further sub-division by any means at our disposal".⁹ Again, in grouping the forces to be found in nature, Stewart listed three groups: those embracing universal gravitation, the molecular forces, and lastly the atomic forces. He distinguished between the last two in the following words:

⁹Ibid., p. 2.

The distinction between molecular and atomic being that molecular forces denote those exerted between particles of the same substance, while atomic forces denote those exerted between particles of different substances.¹⁰

Stewart further indicated his acceptance of the theory of the atomic structure of matter in his discussion of energies which he divided into three major groups: the "molar energies",¹¹ under which were listed the energy of molar motion and the potential energy of molar arrangements; the "heat energies",¹² consisting of the kinetic energy of absorbed heat, of separation (both molecular), and of radiant light and heat; the third group included electrical separation, electricity in motion and chemical separation which he said, may be called "atomic energies".¹³

This is the first reference to atomic energy found in any of the Territorial secondary school physical science textbooks. However, the reference appears to be to the forces among atoms, rather than to energy stored within them. Later, Dr. Stewart, in concluding a summary of the transmutations of energy, points out that his classification of energy into various forms is merely one of convenience and he frankly admits that it "represents the present state of our knowledge of the subject."¹⁴

On the topic of temperature, Stewart used the term to "...denote the state of a body with respect to sensible heat",¹⁵ and goes on to explain the concept in these words, "...we may look upon temperature as heat level, and imagine

¹⁰Ibid., p. 43.

¹¹Ibid., p. 122.

¹²Ibid.

¹³Ibid.

¹⁴Ibid., p. 467.

¹⁵Ibid., p. 194.

that, just as water flows from a high level to a low one, so heat flows from a body of high to one of low temperature."¹⁶

With respect to the theories regarding the nature of light, Stewart wrote that the scientists of the day were agreed that a ray of light was a species of energy and that it represented some type of motion. The theories of light as propounded by Newton and Huygens had been the most accepted explanations of this phenomenon, but Stewart described a tendency to favor Huygen's and reject Newton's theory in these words:

Newton led the way in supposing that light consists of exceedingly small particles projected from a luminous body with enormous velocity while Huyghens supposed it to consist in undulations of an exceedingly rare medium pervading space, and called ether or the ethereal medium.

The explanation of the various phenomena given by the last, or undulatory theory, is very much better than that afforded by the Newtonian theory of emission, so that gradually this theory has become obsolete. It has, however, been very difficult to devise experiments which might serve as a crucial test between the rival hypotheses. Such a test has at length been found.

According to the theory of emissions, the velocity of light ought to be greater in water than in vacuo, while according to the theory of undulations it ought to be less. Now Foucault, who determined the velocity of light by means of a revolving mirror, determined also that its velocity is less in water than in vacuo. The verdict of this experiment is thus in favor of the undulatory theory.¹⁷

Stewart described electricity as being of two kinds, positive and negative, but he did not distinguish between static and current electricity as such. He stated that the energy of electrical separation may be transformed into

¹⁶Ibid.

¹⁷Ibid., pp. 329 - 330.

visible motion when two oppositely charged bodies are joined by a metallic conductor. He then put forward "the hypothesis of two fluids" which he described in these words:

It is not meant here to speculate upon the nature of electricity, but for convenience sake we may regard it as a fluid of which there are two opposite kinds, positive and negative.

According to this hypothesis every substance may be supposed to contain an indefinite quantity of these two electricities mixed together, and neutralizing one another. By various means the two fluids may be separated the one from the other, but whenever we have a certain amount of positive electricity there must be somewhere also just as much negative electricity. Therefore in rubbing together two bodies such as sealing wax and a piece of cloth we do not produce a certain quantity of electricity, by itself, but the sealing wax becomes negatively electrified, while the cloth on which it is rubbed becomes positively electrified.¹⁸

Thus, while Stewart offered some description of the behavior of electricity, it is evident that scientists like himself still had much to learn about the nature of electricity and the explanations of certain phenomena associated with it.

¹⁸Ibid., p. 348.

CHAPTER IV

DEVELOPMENTS IN THE PERIOD 1890 - 1901

A reorganization of the central authority, the appointment of a Superintendent of Education, changes in the elementary school science program, developments in secondary school physical science, a review of some features of the next textbook in physics and some changes in examination papers, are outlined in this chapter.

I. THE COUNCIL OF PUBLIC INSTRUCTION AND DR. GOGGIN (1890 - 1896)

Records of developments in education for the next six years--1890 to 1896--are fragmentary and scarce. Black writes that because of considerable controversy and conflict between ecclesiastical and educational authorities, the Board of Education was abolished in 1892, and educational affairs of the Territories were placed in the hands of the Council of Public Instruction.¹

In 1893 the Council appointed Dr. Goggin, former Principal of the Manitoba Normal School, to the position of Superintendent of Education for the Territories and Principal of the Normal School at Regina. In his position as Superintendent for the next decade, Dr. Goggin has been described as "the guiding spirit in educational affairs".²

During the next few years the concern in education seems to have been centered about the public schools. The reason for this is apparent in the school statistics for 1895 which show that less than two per cent of all pupils

¹Black, N. F., History of Saskatchewan and the North West Territories. (Regina: Saskatchewan Historical Publishers, 1913), p. 784.

²Ibid., p. 785.

were in high school standards, and that eighty-eight per cent did not proceed beyond Standard III. In his report, Superintendent Goggin wrote,

The conditions of life in a new country and the demands of the farm, ranch and shop, account in the main for the early withdrawal from school of so many children. The importance of the education given in the first three standards is greatly increased through this withdrawal.³

This same year it was reported that teachers received their academic training in the high school departments of Public Schools and their professional training in the Normal Schools.⁴ The annual report for 1896 described the program of studies as one which provides for the teaching of those subjects which would contribute to competence in business, good citizenship, bodily health and sound morality. In reference to the high school curriculum, the report states that the work in languages was determined by the matriculation requirements of the universities in Manitoba and Toronto.⁵ It appears from this that these universities did not have requirements in the sciences beyond those stipulated in the academic portion of the teachers' program. Dr. Goggin, in discussing science education in the same report, stated that botany, chemistry and physics, including laboratory work in each subject, were taught in the high school standards. At this time, too, an elementary course in agriculture was reviewed and supplemented. He appeared somewhat critical of the science program when he wrote:

...The course is less liberal than it should be owing to the pupils not having that foundation knowledge of the facts of Nature and power of

³Report of the Council of Public Instruction, North West Territories, 1896, p. 13.

⁴Ibid., p. 11.

⁵Ibid.

accurate observation, and method of study which they should have received in the Elementary Standards.⁶

However, he concluded by expressing confidence that the recently inaugurated course in Nature Study would enable elementary pupils to do improved work in a science when they reached high school. From these remarks, it would appear that Dr. Goggin felt that nature study in the elementary grades was a necessary and proper foundation for subsequent studies in all fields of science and not just the biological or agricultural branches.

Among existing records, the best clues as to the specific content of the physical science courses studied at this time are found in the questions from the non-professional examinations for teachers (see Appendices A and B, pages 156 and 169 - 175 respectively.)

II. THE PROGRAM IN PHYSICAL SCIENCE, 1896 - 1902

The Education Report of the Council of Public Instruction for 1896 contains limited information on the physical science program in Territorial schools. Appendix B of this Report, under the heading of "Non-Professional Examinations", gives the following information: Physics was included in the subjects for all three classes of teachers' certificates; the textbook used was Gage's Introduction to Physical Science. The Physics examination written by candidates for the Third Class Certificate covered the elements of physics as contained in Chapters I, II, III and IV in the prescribed text. The program in physics for candidates for the Second Class Certificate was also labelled "The Elements of Physics" and the same

⁶Ibid., p. 27.

text is listed, but the chapters to be studied are not specified. Candidates for a First Class Certificate were required to write papers in both physics and chemistry. The same textbook in physics was prescribed for First Class Certificate candidates as was used for the Third and Second Class Certificates. The text listed in chemistry was Kirkland's Experimental Chemistry (Gage and Company) but no outline of the course is given. Appendix D, page 215, lists the main topics covered by Gage's text in physics. Appendix B, pages 171 - 172 contains the examination papers in physics. An examination of these sources reveals that the studies in physics for standard V (Third Class Non-Professional Teaching Certificate) included Matter, Energy, Motion and Force; Dynamics of Fluids; General Dynamics; Work and Energy, with considerable emphasis on the study of fluids and on Newton's three laws of motion and their applications.

It is difficult to determine with precision the content of the last two years of studies in physics. The textbook contains certain sections which are in fine print. According to the author, these are to be regarded not as a necessary part of the basic course in physics but as supplementary material for additional reading, or to be used selectively to complement the basic program. However, the paper for candidates seeking to qualify for the Second Class Certificate had a question on the phonograph, which was discussed in just such a supplementary section. Another complicating factor was the practice of asking about half of the examination questions on the work of the current year and the other half on material studied in the previous school year. This procedure also made the writing of examinations more difficult, as attested to by the criticisms

of the sub-examiners who marked the candidates' answer papers.⁷

The physical science program of studies in Territorial schools seems to have remained relatively unchanged between the years 1896 and 1902, with the exception of a review by Dr. Goggin in 1898.⁸ In this he was concerned with a more detailed outline of the courses in physics and botany. The same textbooks remained in use and the plan requiring three years of physics and one year of chemistry was retained. The course in Standard VI, which comprised also the non-professional part of the course for the Third Class Teachers' Certificate, is outlined in considerable detail in the annual report of the Council of Public Instruction of the North West Territories for 1900, and is to be found in Appendix C, page 189. It is included, not only because of the information it provides about the program itself, but also because it appears to be the forerunner of the "Courses of Studies" and "Curriculum Guides", of more recent times, which set forth in detail the program to be followed in the schools.

An analysis of the non-professional examinations for teachers in both physics and chemistry for 1900, and a comparison with those of a decade earlier, reveal certain changes. Most obvious among these is an increase in the length of the paper, both in time, and in the number of questions asked. In physics there is a discernible adjustment in emphasis from testing the memorization of facts alone to testing more for an understanding and application of principles. Besides questions which ask candidates,

⁷Report of the Department of Education, North West Territories, 1902, p. 24.

⁸Annual Report of the Board, of Education, North West Territories, 1898, pp. 46 - 47.

"What is?" and "Describe", we find more of the type that ask, "How?", "What is meant by?", "Compare", "Explain" and "Why?" The caption on the 1900 Physics examination for candidates seeking a second class certificate, points out that they will be given credit for "...neat illustrative drawings"⁹ and Question 6(b) on the same paper directs them specifically to "...describe by means of diagrams..."¹⁰ Several other questions are such that diagrams may be used in the required explanation.

In 1900 the Chemistry paper was no longer combined with the paper in Botany, as had been the practice in the early 1890's, yet it required the same amount of time as had been allotted to these two subjects in 1890 and 1891. This fact, combined with a greater number of questions on the paper, is indicative of increasing recognition of the worthiness of chemistry as a subject in the high school program. Less encouraging, however, was the lack of change from that type of question which requires little more from candidates than a diligent memorization of factual material from a textbook (See Appendix A, page 157). Because the course in chemistry was given only one year in the program, it remained essentially an elementary course, introductory in nature.

Thus, while examination papers provided some indication of the total secondary school program, the details of the curriculum studied in each year are rather obscure. Some further insight regarding the physics program in the schools of the time may be gleaned from a closer examination of the textbook.

⁹Annual Report of the Board of Education, North West Territories, 1900, p. 107.

¹⁰Ibid.

III. DR. GAGE'S FIRST TEXTBOOK IN PHYSICS

Nature and Organization of the Text

In his "Author's Preface", Dr. Gage advocated the use of a textbook prepared on the inductive plan coupled with a similar approach in the classroom, and suggested that under these conditions "pupils can scarcely miss catching the spirit and methods of the investigator".¹¹ He then outlined his method of conducting the laboratory in physics--a method requiring students to keep their notebooks in the laboratory at all times and to write their reports immediately upon completion of an experiment. Dr. Gage ended his preface with the following words:

It has been my aim in the preparation of this book to adapt to the requirements and facilities of the average high school. With this view, I have endeavored to bring the subjects taught within the easy comprehension of the ordinary pupil of this grade, without attempting to popularize them by use of loose and unscientific language, or fanciful and misleading illustrations and analogies which might leave much to be untaught in after time. Especially has it been my purpose to carefully guard against the introduction of any teachings not in harmony with the most modern conceptions of Physical Science."¹²

The first section of Chapter One begins with a message to the teacher in which Dr. Gage offered the reminder that "...recitations from memory of mere descriptive physics and chemistry is of little educational value."¹³

At the same time, he encouraged the pupil to study the wonders of nature through observation, experiment and

¹¹Gage, A. P., Introduction to Physical Science. (Toronto: A. P. Gage and Company, 1892). Author's Preface.

¹²Ibid.

¹³Ibid., p. 1.

use of his own intellect, relying on teachers and books as sources of advice for procedures to follow in the acquisition of knowledge rather than as the sources of knowledge.

The description of an experiment in the text was usually accompanied by a photograph or perspective drawing of the apparatus with very little use being made of cross-sectional diagrams. There were very few questions and even fewer problems scattered throughout the book rather than clustered at the ends of chapters.

Selected Topics

In discussing the theory of the constitution of matter, this text, though it does not mention atoms, describes all matter as consisting of molecules which are in constant vibration. The siphon received a prominent and detailed discussion--page 55 being a full-page cut representing "some of the great variety of uses to which the siphon may be put." Some of the ideas presented to students may be illustrated by the following quotations which are also indicative of the language and manner of expression used in the textbook.

1) Potential Energy:

A body possesses potential energy when, in virtue of work done upon it, it occupies a position of advantage, or its molecules occupy positions of advantage, so that the energy expended can be at any time recovered by the return of its molecules to their original positions.¹⁴

2) The Distinction Between Force and Energy:

Energy which is the product of force into space cannot be measured directly by any instrument. Force can be increased indefinitely by means of machines as a lever, hydrostatic press, etc.; energy cannot be increased by any instrument or means whatsoever.¹⁵

¹⁴Ibid., p. 101.

¹⁵Ibid., p. 102.

3) Theory of Heat and Temperature:

According to this view heat is but a name for the energy of vibration of molecules of a body. A body is heated by having the motion of its molecules quickened and cooled by parting with some of its molecular motion. One body is hotter than another when the average kinetic energy of each molecule in it is greater than in the other.¹⁶

This explanation of heat and its transfer contrasts sharply with that offered by Balfour Stewart and is essentially in agreement with that found in modern textbooks.¹⁷

4) Radiant Energy and Its Transmission from Sun to Earth:

(Dr. Gage on page 282 had presented a description of the radiometer, its construction and operation. In his subsequent discussion he wrote as follows:)

In just what manner it is caused to rotate does not concern us at present; but the fact that it rotates and that it is caused to rotate directly or indirectly by something that comes from the sun, is pertinent to the question before us. Whenever a body is caused to move or increase its rate of motion, energy must be imparted to it; hence energy must be imparted to the radiometer vane by the sun.

That which we receive from the sun, whether it affects the sense of touch or sight, or produces chemical changes is in reality some form of energy and is one and the same form whatever the effect.

Ether, the Medium of Motion--If we receive the energy of motion, what moves? Our atmosphere is but a thin mantle covering the earth, while the great space that separates us from the sun contains no air or other known substance. But empty space cannot communicate motion. It is assumed--it is necessary to assume--that there is some medium filling interplanetary space; in fact, filling all space otherwise unoccupied, a medium by which motion can be communicated from one point to another. This medium has received the name of ether.

¹⁶ Ibid., p. 121.

¹⁷ Supra, pp. 24 - 25.

We cannot see, hear, feel, taste, smell, weigh nor measure it. What evidence have we that ether exists? This: Phenomena occur just as they would occur if all space were filled with an ethereal medium capable of transmitting motion; we have been able to account for this hypothesis on no other hypothesis, hence our belief in the existence of the medium.

The transmission of energy through the medium of ether is called radiation; energy so transmitted is called radiant energy, and the body emitting energy in this manner is called a radiator.¹⁸

The foregoing excerpts from Gage's book indicate that some of the concepts presented to students were very similar to those to be found in present textbooks. Others were totally different, some having been subsequently rejected. Specific examples of similarity would include the molecular concept of the structure of matter and the concepts regarding the nature of heat and temperature. On the other hand, there appears to have been no conception that differences in potential energy might be due to variations in the structure and composition of molecules as well as to differences in their positions; nor is the atom mentioned in any of the discussions. Other ideas subsequently rejected were the existence of the ether and the necessity of a medium for the transmission of energy. Despite their eventual rejection by scientists, these concepts were retained in the physics textbooks for an unusually long period of time.

¹⁸Gage, A. P., Introduction to Physical Science. (Toronto: A. P. Gage and Company, 1892), p. 282 - 283.

CHAPTER V

THE LAST YEARS UNDER TERRITORIAL GOVERNMENT:

THE 1902 REVISION

A change in government organization with respect to education; a major revision of the high school curriculum; some of the philosophy concerning education at the secondary school level, particularly as it affected science education; and the content of the revised courses in physical science are discussed in this chapter.

I. EDUCATION ACCORDED DEPARTMENTAL STATUS

In 1901 the Council of Public Instruction was replaced by a Territorial Department of Education. Thus, Education was at last recognized as a major public service and placed on an equal basis with other departments in the organizational scheme of government. It has retained this position under a cabinet minister ever since, and as a consequence, there has been a good measure of central control in education in Alberta, particularly in the matter of curriculum.

Dr. Goggin was retained as Superintendent of Schools and assigned the task of revising the high school curriculum. Nothing in the records indicates that he had any help in this important and responsible undertaking, which was so ably performed that the resulting program survived the transition period during which Saskatchewan and Alberta achieved provincial status, and continued in use in Alberta until 1912. With respect to the physical science courses in the new program, minor adjustments, such as those resulting from the adoption of revised editions of textbooks, were made, but major changes were not undertaken despite the fact that the University of Alberta opened its doors in 1908.

II. EDUCATION IN THE TERRITORIES AT THE BEGINNING OF THE CENTURY

The Purpose to be Served by Secondary Schools

The objectives of education are major factors in determining the content of the curriculum.¹ Consequently, the emphasis given to physical science at a particular time is greatly influenced by current philosophy regarding the function of the schools. Of particular significance to this study is the philosophy regarding the purposes to be served by secondary schools. For this reason statements relating to the functions of the high schools, as revealed in official reports prior to the 1902 revision, were investigated. The only opinions in available records were those expressed by Dr. Goggin, the Superintendent of Schools. However, these were published, without any qualifying statements whatsoever, by the Council of Public Instruction, so it is most unlikely that they could have misrepresented the views of the Council itself.

In the first part of his report, Dr. Goggin expressed the opinion that the school is only one of the agencies effective in the preparation of youth for adulthood. He made it clear that while he considered that the school has two major functions to perform, it does not operate in isolation from other factors in society. His opinions were aptly expressed in the following paragraph from his report to Mr. F. W. G. Haultain, Chairman of the Council of Public Instruction:

Courses of study and methods of teaching are shaped by certain considerations. The pupil must be prepared as a member of society to live a worthy life and earn a respectable living. The family,

¹Beauchamp, George A., Curriculum Theory. (Wilmette, Illinois: The Kagg Press, 1961), p. 118.

society, the state, the church and the vocation and the school must cooperate in preparing him for his twofold life work.²

In another section of the same report, Dr. Goggin eloquently expressed some of his own concepts and ideas about the purposes and objectives of secondary education. He wrote as follows:

The state recognizes that the educated citizen is capable of higher service than the uneducated one, that the broader a man's views and the more liberal his culture the more intelligent will be his grasp of state needs and the more effective his labours on its behalf. The local community and the family recognize that the enrichment of the individual through liberal instruction and training along cultural, social and vocational lines means an improved home and community life. So these three agencies unite to provide, in the high school, opportunity for this instruction, training and culture for all who can take advantage of it. On these grounds mainly it claims and receives public support.

Except incidentally, it is not a fitting school for university or college or normal school. It is not a select school for the wealthy or the well born or intellectually gifted. It is for all who feel the need and believe in the benefits of education. It supplements and amplifies the work of the elementary school and gives a more adequate, because a broader, preparation for life.

The great majority of high school pupils do not go to college and should not prepare for teachers' examinations. It is the needs of pupils and not the entrance requirements of colleges and professional schools that must shape the high school courses of studies. The training undergone, the habits formed, and the knowledge of literature, history, mathematics and science acquired in obtaining a satisfactory preparation for life must surely be a good foundation on which to base the higher studies of the colleges and professional schools.³

²Report of the Council of Public Instruction of the North West Territories, 1900, p. 21.

³Ibid., pp. 26 - 27.

Dr. Goggin's remarks indicate that he considered studies in science to be an integral part of the secondary school curriculum along with history, literature and mathematics. However, he also emphasizes that the considered purpose of the secondary school was a broad preparation for life, and in this respect reaffirmed the position indicated by the Territorial Board of Education in its directive to principals in 1897.⁴

Criticisms of the Physics Courses

Although Dr. Goggin's report in 1900 does not reveal personal dissatisfaction with any particular phase of the program at this time, evidence of discontent is revealed in the criticism by some of the sub-examiners marking candidates' examination papers in physics.

With reference to the paper in standard VI, one sub-examiner wrote:

Candidates as a rule appear to have covered the prescribed work but not thoroughly; they are unable to apply the principles they have learned. This is attributed to the extent of the course and the lack of time for drill in applications.⁵

These observations are supported by another sub-examiner who offered this criticism of the candidates' papers in standard VII:

The candidates' answers indicate a fairly complete knowledge of definitions and principles but a very general inability to apply the knowledge in special cases. This application very properly forms an important part of a paper in any such subject, so that weakness here is serious. When the principles are once established the pupils' reasoning power should be developed by requiring them to make many applications of the knowledge gained. Herein our work seems defective.⁶

⁴Supra, p. 18.

⁵Report of the Council of Public Instruction of the North West Territories, 1900, p. 24.

⁶Ibid.

He continues his criticism by stating that in his own experience in the classroom the breadth of content was such that there was sufficient time only to scarcely establish one principle before it was necessary to rush on to the next topic. This sub-examiner concluded his criticism by stating emphatically, "...the course should be shortened."⁷

III. THE NEW PROGRAM OF STUDIES, 1902

The Annual Report of the Department of Education for 1902 heralds the introduction of the elective principle into the high school curriculum. The fixed program previously followed was to be abandoned, and henceforth some subjects were to be compulsory, some optional, and others would be elective.⁸ From the standpoint of its impact on studies in physical science the new program included an elementary course in chemistry for standard VII. Although the course was placed among the optional subjects, this appears to be the first time that chemistry made its way into the regular program. Previously, it had been studied only by candidates for the first class teachers' certificate and those requiring chemistry to prepare for university entrance examinations. On the negative side, as far as physical science was concerned, candidates for teaching were now enabled to choose either French or German instead of chemistry. No matriculation program was set forth because there was not yet any university within the Territories. However, some co-ordination of the courses in Latin, Greek and French was made with the University of Manitoba. Apparently this harmonizing of the language programs was sufficient to make it no longer necessary to hold separate matriculation examinations in May as had been the practice formerly.⁹ Because of the elective

⁷Ibid.

⁸Annual Report of the Department of Education of the North West Territories, 1902, p. 17.

⁹Ibid.

nature of the program, candidates desiring standing equivalent to matriculation were cautioned to select the subjects prescribed therefor by the University.

An examination of the revised program of studies for standards VI, VII and VIII shows that despite introduction of the elective principle and the reductions in certain subjects there continued to be such a multiplicity of courses in each high school standard as to render thorough treatment of any subject a physical impossibility in the time that was available. The emphasis in the new curriculum appears to have been more with breadth of coverage and less with depth of content. In this respect the program was designed more as a general education for all students and less exclusively as preparation to meet the matriculation requirements of universities.

There is evidence too that the revised curriculum attempted to encourage more students to proceed to the secondary school. As pointed out in the previous paragraph, chemistry was transferred from standard VIII to standard VII and made more introductory in nature. Physics was removed from standard VII, the course in standard VI was rewritten and a new textbook authorized. This revised course for standard VI appears to mark the first time the curriculum recognized, in a meaningful way, that a considerable transition confronted pupils graduating from the nature study courses in the public or elementary schools to a study of physical science at the secondary level. Until this time the secondary school program in physics was mainly the textbook, which was divided, rather arbitrarily, into the work of the three standards. Little, if any, consideration seemingly was given to a sequential arrangement from the more elementary to the more complex as the

student matured and grew in his knowledge of the subject. High School Physical Science, Part I, which replaced the book by Gage as the textbook for standard VI, was definitely an introductory course designed to bridge the gap between elementary and high school.¹⁰ The content introduced the student to most of the major areas in physics, but made no attempt to pursue any area in depth. This was especially true with respect to the treatment of motion, light and electricity. Since the prescribed textbook offers the most complete outline of the course, a more detailed discussion of its organization and content, as indicated from a revised edition of 1905, is included in the next section.

IV. MERCHANT AND FESSENDEN'S HIGH SCHOOL PHYSICAL SCIENCE Nature and Organization of the Text

The new textbook for the study of physics in standard VI was described by its authors as having been written "...for continuation classes in public schools and lower classes in secondary schools."¹¹ In their preface they describe the experiments contained in the book as "...simple and typical which can be performed by the pupils themselves with inexpensive apparatus."¹² The textbook was based on a laboratory or experimental approach to the study of physics and contained numerous experiments. The apparatus required was usually illustrated, the procedure carefully described and a series of leading questions presented to help the student in making observations and reaching conclusions. Most of the experiments were of a qualitative nature, in

¹⁰ Merchant, F. W. and Fessenden, M. A., High School Physical Science, Part I (Revised Edition). (Toronto: The Copp Clark Company, 1905). pp. i - iii.

¹¹ Ibid., p. i.

¹² Ibid., p. iii.

keeping with the general approach used throughout the textbook. The sections dealing with such topics as specific gravity, latent heat and calorimetry, contain some simple quantitative experiments and also some problems involving quantitative determinations. The following quotation would seem to sum up the general approach to the subject followed in most parts of the textbook:

The scientific method and habit of enquiry acquired through laboratory practice is most valuable, but experience shows that the knowledge gained by beginners from laboratory work alone is inaccurate and fragmentary. The effort has been made to meet the situation by giving formulated statements of the more important principles, and at the same time, by supplying abundant material for original investigation in connection with the development and application of the principles.¹³

A new feature of this textbook was an appendix containing instructions for the making of certain pieces of apparatus required to carry out some of the experiments. This was to be done by the students in their classes in manual training, not for reasons of economy, but because "...such exercises add value to the course of study in both Manual Training and Physics."¹⁴ It was suggested that this would provide the added incentive of a definite purpose to projects in shop classes, and that in physics a student who had constructed his own apparatus to the required specifications and had then conducted his experiment with it, "...has a grasp of the fundamental principles underlying the experiment, and has acquired a scientific interest and spirit wanting in the student who has worked with ready-made apparatus."¹⁵

¹³Ibid., p. i.

¹⁴Ibid., p. iv.

¹⁵Ibid.

Selected Topics From Merchant and Fessenden, 1905

The Constitution of Matter--Molecular Theory. No reference was made to atoms or atomic theory but the molecular theory of the constitution of matter was presented and used as a basis for explaining the distinctions among the three states of matter, diffusion of liquids and gases, and the dissolution of one substance in another.¹⁶ It was also the basis for defining temperature and distinguishing between the temperature of a body and the quantity of heat it contains.¹⁷

The explanation of surface tension in liquids, however, was in no way based on molecular theory. The floating of a steel needle on the surface of a glass of water was said to be due to the fact that:

The superficial film of a liquid is more viscous than the interior. This film is therefore hard to break, and bodies which would naturally sink if placed in the interior of the liquid are borne up by it.¹⁸

The authors, in summarizing a number of experiments illustrating this phenomenon remark:

The experiments in this and preceding sections tend to show that the surface film of a liquid acts as if it were a thin elastic skin, somewhat tough and viscous, stretched tightly over the liquid.¹⁹

Energy, Its Forms and Transmutation. The principle of conservation in any transformation or transference of energy was recognized, as was the fact that energy exists in many forms.²⁰ The various forms of energy were, however,

¹⁶Ibid., pp. 38, 39 and 138 - 140.

¹⁷Ibid., p. 218.

¹⁸Ibid., p. 90.

¹⁹Ibid., p. 91.

²⁰Ibid., p. 157.

thought to be necessarily associated with matter in motion. Merchant and Fessenden wrote:

We are thus led to see that there are various forms of energy, all doubtless possessed by matter of some kind having some mode of motion.

- 1) Energy of bodily onward motion.
- 2) Energy of bodily vibration.
- 3) Energy of molecular vibration, or heat.
- 4) Radiant energy, or the energy possessed by the intangible medium called luminiferous ether, which we suppose to fill all space.
- 5) The mysterious forms of energy which produce gravitation, chemical affinity, magnetic attraction, magnetic repulsion, etc., and which may be forms of radiant energy.
- 6) The energy of the electric current, which is well exhibited in the electric motion. This also is probably a form of radiant energy.²¹

Radiation. Radiation was considered as a method by which heat is transmitted even in the most perfect vacuum that could be produced, it was considered necessary to suppose the existence, in space, of a medium called the ether. The rapid motion of molecules in a hot body set up vibrations in the ethereal medium which passed this energy along to the molecules of other substances, thereby heating them.²²

Light. Visible light was described as "...radiant energy which can affect the eye and produce vision."²³ It was said that ether-waves whose wave-lengths and frequencies were within certain limits act as stimuli on the retina of the eye.

Electricity. Static electricity was not considered at all in the textbook by Merchant and Fessenden. They

²¹Ibid., p. 156.

²²Ibid., p. 245.

²³Ibid., p. 251.

introduced their discussion of the electric current by describing a simple experiment involving a copper wire placed above a compass needle and connecting a strip of zinc to a strip of copper, both resting in a beaker of dilute sulphuric acid. The student was asked to note any changes in the direction of the needle when the wire was placed above it, then below it.²⁴ The new properties possessed by the wire were attributed to the fact that an electric current was passing through it, but the authors then hastened to qualify their use of the term "current" by explaining:

In using the term current, it must not be supposed that we know for a certainty that something is in reality flowing through the wire which is said to conduct the current. On account of the analogy of the conditions and effects to those of fluids flowing in pipes, the terms applied to this form of energy are those commonly applied to currents.

By the work which the so-called current will do, we recognize the presence of energy, but we are in ignorance of its nature. No theory regarding it is as yet universally accepted by scientists.²⁵

The operation of a simple voltaic cell was discussed and a chemical equation for the reaction between the zinc plate and the sulphuric acid given, but the explanation of the production of a current of electricity by the cell is vague indeed. It was observed that chemical action always accompanied the production of a current by the cell, but the authors were of the opinion that "no satisfactory evidence is found to show that the electric current is the result of the chemical action..."²⁶

²⁴Ibid., p. 291.

²⁵Ibid., p. 292.

²⁶Ibid., p. 295.

V. DR. GAGE'S NEW PHYSICAL SCIENCE TEXT

Nature and Organization

In standard VIII the program was captioned, "The Elements of Physics" and a 1902 revision of Introduction to Physical Science by Dr. A. P. Gage was prescribed as the text. This was a revised edition of the book formerly used in all three high school standards. Some of the comments made by Dr. Gage in the preface of his new textbook seem to be indicative of an increased concern, on the part of educationists, for a successful physical science program in the secondary school, and are therefore included here. Dr. Gage wrote as follows:

Methods of teaching elementary physics have undergone, within scarcely more than a decade, many radical changes. The education pendulum has vibrated between extreme methods of all textbook and no textbook, all laboratory and no laboratory, the inductive method and the deductive method, all oral instruction and little oral instruction. At present it seems to have approached the point of equilibrium where the good in each of these methods is given its due weight. It appears to be the consensus of opinion among teachers of physics that the method of instruction which includes a due proportion of text-book study, lecture-room demonstration, and individual work in the laboratory is the method conducive to the highest order of results from an educational point of view.²⁷

To the extent that these remarks are representative of the thinking of the time, they reveal a growing concern on the part of the writers of science textbooks about the ways that students learn. There appears to be greater concern with the responsibility of the teacher for understanding on the part of the pupil and certainly Dr. Gage is much less sure than he was in the preface of the 1892 edition, as to the way to present a course in high school physics.

²⁷Gage, Alfred P., Introduction to Physical Science, Revised Edition. (Toronto: W. J. Gage and Company, 1902). pp. iii - iv.

There also appears to have been more attention paid to clarity in presentation of important principles so that the student was not befuddled by numerous minutiae. As Dr. Gage said:

It has been the author's purpose to place before the pupil in simple language and in logical order, with due regard to child psychology, the general principles and the important laws of physical science, and not allow them to be obscured by a multiplicity of experimental details which would be more appropriate in a teachers' manual or in a laboratory manual.²⁸

In Dr. Gage's opinion, his textbook included sufficient material for a year's work provided that about one-third of the time was spent conducting experiments in the laboratory. His revised textbook was divided into eight major chapters or areas, including a definition of physics and description of the properties of matter, fluid pressure, dynamics, heat, sound, radiant energy and light, electrostatics and electrokinetics, which dealt with energy due to current flow and included magnetism among its sub-topics.

Because the definition given by an author may often reveal important aspects of his concept of the subject, Dr. Gage's definition of physics is included at this point. "Physics is the science which treats of matter and its motion, and of vibrations in the ether."²⁹ The molecular theory was accepted in the book, and the phenomena of compressibility and expansibility of matter were offered as evidence supporting this explanation of the structure of matter. However, a statement that "...every body of matter except the molecule is composed of exceedingly small

²⁸Ibid.

²⁹Ibid., p. 2.

disconnected particles, called molecules"³⁰, casts doubt as to whether or not Dr. Gage was prepared to accept fully the concept of the atom as the basic building block of matter.

A notable departure from former texts was the fact that the laboratory work for pupils had not been incorporated into the textbook. Instead, the teacher was directed to select a laboratory manual adapted to his own ideas and methods.³¹ Another innovation was the inclusion of a number of portraits of famous scientists which were interspersed throughout the book. These, together with various references to historic events in science, were intended to make the subject more attractive and more human in the eyes of the student.³² This revised edition of Dr. Gage's earlier work also included a greater number of exercises which showed increased variation in type. Some of the questions, for example, even included diagrams of certain apparatus upon which the question was based. Occasionally, the answer to a numerical or quantitative problem was included, but there was not yet a sufficient number of these in the book for the author to consider it necessary to append a section of answers to his textbook.

Selected Topics

Among significant additions to the context was the inclusion, in the discussion of heat and temperature, of the idea that the temperature of a body is directly proportional to the average of the squares of the velocities of its molecules. This was a refinement over the presentation in the earlier text of 1892 in which temperature had been related only to the average kinetic energy of the

³⁰Ibid., p. 4.

³¹Ibid., p. iv.

³²Ibid.

molecules of a substance.³³ The concept of specific heat of a substance was also introduced and a rather crude experiment for the determination of same, which did not make allowance for the heat absorbed by the calorimeter, was included.

In discussing the theory of light and the ether, Gage described the emission or corpuscular theory propounded by Sir Isaac Newton, but stated that because it had been found "...incapable of explaining, and in some cases wholly inconsistent with, many phenomena discovered since Newton's time,"³⁴ it had by then been discarded by scientists. He described the accepted theory of the day as being the undulatory or wave theory, which he said was based upon the concept that energy could be transmitted only by means of a material medium. It was by means of wave motion, in this all-pervading, invisible, weightless, colorless and odorless and highly elastic medium, that energy was transmitted. While admitting that this unique substance was still rather more a mystery than a fact, Gage offers the following rather illogical and unscientific explanation for accepting the idea of the existence of the ether,

The evidence that it exists briefly stated, is, that only on the hypothesis that all space is filled with a medium capable of transmitting energy in the form of wave motion are we able to offer rational explanation for all known optical phenomena.³⁵

Gage argued that light is a sensation perceived through the eye much as sound is a sensation perceived through the ear. There existed, he says, a common misapplication or confusion

³³Supra, p. 35.

³⁴Gage, A. P., Introduction to Physical Science, Revised Edition. (Toronto: W. J. Gage and Company, 1902). p. 207.

³⁵Ibid.

of meanings with respect to these terms. The misunderstanding arose, he contended, from application of the terms to that which produced the sensations rather than to the sensations themselves. Light he defined as, "...that wave motion in the ether which may be appreciated by the eye."³⁶

In another section, Gage stated most definitely that heat was not transmitted by radiation; rather, he argued, it was the radiation that travelled and not the heat. To account for the fact that celestial space is cold, he reasoned that because the energy did not exist as heat in space, it was not necessary that it heat the substance filling that space. The sun, it was contended, sends us no heat, but radiations instead, which the earth then converts into heat. Heat was depicted as travelling in one direction only and that was from one point in matter to another point that was at a lower temperature. It was said to travel through matter by the process of conduction, and with matter by means of convection. Radiations were defined as waves in the ether; they were not considered as heat, and heat was definitely to be distinguished from radiations.³⁷

The last section of the final chapter in Gage's textbook consisted of a discussion of more recent developments in physics pertaining especially to the work of Maxwell, Hertz and Roentgen. According to Gage's description, Maxwell's theory contended that light waves are essentially electromagnetic waves in the ether and that visible light represented a limited range of wave-lengths from among these. He said that Maxwell's theory was considered as having been verified by the work of Hertz and concluded his book with the argument that the chief importance of this theory, from a scientific point of view,

³⁶Ibid., p. 207.

³⁷Ibid., p. 261.

was that it provided additional support for the concept that the ether is the medium by which many forms of energy are transferred through space from one place to another.³⁸ Radiant energy, he described as a concept that was continuously acquiring broadened meanings.

In this prediction, Dr. Gage seems to have been much more correct than he was in his prophecy about the universal adoption of the metric system of measurement. Near the beginning of his book he praised the simplicity of this system, mentioned its almost universal adoption throughout the scientific world and confidently predicted that it was, as he put it, "...destined to supplant completely, at no distant day, the irrational and unwieldy British units."³⁹ How amazed he might have been, sixty years later, to find the two systems still in use in much the same ways as they had been at the dawn of the century!

³⁸Ibid., p. 345.

³⁹Ibid., p. 9.

CHAPTER VI

THE PHYSICAL SCIENCE PROGRAM AND GENERAL CONDITIONS IN THE PROVINCE'S HIGH SCHOOLS TO 1912

With the exception of rather minor changes, the curriculum, as revised by Dr. Goggin in 1902, was retained in Alberta schools for the first seven years of the province's history. In physical science, the changes consisted chiefly in the adoption of different textbooks or revised editions of those prescribed in 1902, the introduction of a second year of chemistry in standard VIII as an optional subject with physics, and the return of physics as an option in standard VII. During this period important developments which had a less direct bearing on the physical science program, were the establishment of the Province of Alberta and the selection of Dr. H. M. Tory, President of the University, to head a committee whose task would be the complete revision of the program of studies for Alberta schools.

I. DEVELOPMENTS AND CONDITIONS AFFECTING EDUCATION

IN THE EARLY HIGH SCHOOLS

Alberta acquired provincial status in 1905, but this change seems to have had little initial effect on education in the public and secondary schools. Central control through the Department of Education under Territorial government passed to central control under Provincial government as provided for under the terms of the Alberta Act, the Department of Education Act, and the School Act. The curriculum to be followed and the textbooks to be used were to be prescribed by the Department. The local school district was to be responsible for the management of the school, including financial arrangements for the buildings and equipment. This system was to impose serious financial limitations on the school districts in the province because their sources of revenue were limited to receipts

from taxes levied against land and businesses. Moreover, the assessed values of these sources was necessarily quite limited because of the newness of the country and consequent lack of development of the natural resources.

During the first year of operation under provincial status less than three per cent of the province's school population was to be found in the three high school standards and ninety-one per cent of all pupils were in the first four standards.¹ Thus the main concern, as it had been under the Territorial government, was elementary education. However, the Minister of Education in his first report to the Lieutenant Governor expressed concern over the growing need for high schools in the following words:

...The need for secondary education is becoming more and more apparent inasmuch as our schools cannot supply more than one third of the additional teachers required each year for the schools of the province.²

Other evidence that the need for teachers was a major factor providing impetus for the expansion of the secondary school system was the fact that each successful candidate in the standard VI, VII and VIII examinations was granted a diploma which exempted him from further academic courses in fulfilling the requirements for third, second and first class teachers' certificates respectively.³

In addition to the prospect of almost certain employment as teachers, there were, of course, other incentives prompting young Albertans to pursue more advanced studies and consequently there was a growing demand for secondary, and even higher education. The situation with respect to secondary education in Alberta in 1906 is expressed in the

¹Province of Alberta, Department of Education.
Annual Report, 1906, pp. 12 - 13.

²Ibid.

³Ibid., p. 16.

following excerpt from the report of Honourable A. C. Rutherford, first Minister of Education for the Province of Alberta:

The time has now come when it is essential that greater attention be given our secondary schools and already steps have been taken to encourage the higher departments in our schools by additional grants. The development of a system of secondary education will occupy the attention of the department and the Government until secondary schools are placed on a satisfactory basis. In addition to this the preliminary steps have been taken for the establishment of a Provincial University and elsewhere in this report will be found a copy of the act passed with this object in view.⁴

II. ESTABLISHMENT OF THE UNIVERSITY OF ALBERTA; THE INFLUENCE OF DR. H. M. TORY

The University of Alberta first opened its doors to students in 1908.⁵ Among the many problems confronting President Dr. H. M. Tory and the Senate was the question of standards. If the University of Alberta was to become a first rate university, rather than a small college, Dr. Tory felt that the following conditions must be assured:

- 1) a highly qualified staff of teachers;
- 2) freedom from political pressure in the matter of appointments;
- 3) matriculation standards comparable to those prevailing in the major Canadian universities.⁶

Apparently opposition to the first two was completely lacking, but the third requirement posed several problems. Among the first students to enter the university were found

⁴Ibid., p. 18.

⁵Province of Alberta, Department of Education. Annual Report, 1908, p. 1.

⁶Corbett, E. A., Henry Marshall Tory, Beloved Canadian. (Toronto: The Ryerson Press, 1954). p. 108.

many who had been inadequately prepared in the Province's first high schools, and the university staff found it necessary to devote many additional hours helping these young people overcome their deficiencies.⁷ Dr. Tory apparently felt that the establishment of standards of matriculation for the province's high schools, though a step in the right direction, was inadequate because it did not go far enough. In discussing Tory's views on the matter, Corbett said that the University's first President:

...believed that all educational work from the elementary school to the last grade of high school should be integrated in such a way as to make the university a coping stone, and a co-ordinating agency of the whole educational system of the Province.⁸

With respect to science education Dr. Tory, in a letter to Dr. Alexander, Professor of Classics at the University of Alberta, revealed that he considered science to hold an important place in the advancement of civilized man. Dr. Tory wrote:

I do not agree with you that 'collection of facts, only, is the work of science'. The combining of these into competent theories to explain the facts is now and always has been regarded as the function of the scientist. The truth is the two things cannot be separated.

The great scientists have all combined the speculative quality of mind with the power and will to observe, but while neither the scientist nor the philosopher, nor the theologian has yet given us the final answer, science alone has carried us into regions where behind is a firm bases of acquired knowledge, and before us new fields definitely defined, awaiting the investigating mind. The truth is that progress has been made by the two methods, the extension of speculative ideas and the extension of scientific knowledge.⁹

⁷Ibid.

⁸Ibid., p. 109.

⁹Ibid., pp. 219 - 220.

Dr. Tory felt, too, that although the price was high in terms of the few great scholars produced by our educational system as compared to the many mediocre students, this had always been the case and there was little danger of too many being educated in a society which is based essentially on technology. He contended that the undergraduate courses of today should comprise the high school courses of tomorrow and that the high school of the future should be so organized that the university would then begin at what was presently the third year level.

Of course, Dr. Tory's opinions were not shared by everyone, and he had to compromise a number of his ideals for the sake of what was feasible under conditions as they existed at the time. Nevertheless, he was selected to preside over a Curriculum Revision Committee appointed by the Department of Education, and there can be little doubt that such a capable administrator and forceful personality was able to exert considerable influence in the drafting of the revised curriculum which was adopted by the Alberta government for use in the province's schools.¹⁰

III. THE SECONDARY PHYSICAL SCIENCE PROGRAM IN ALBERTA 1906 - 1911

The physical science program as prescribed for Alberta high schools in the first year of operation under provincial status is shown in Appendix C, page 191. This program followed very closely the course outlined by Dr. Goggin in 1902. Appendix C, page 192, contains the program for the high school standards in Alberta for the school years 1906 - 1907 and 1910 - 1911 inclusive. Among the changes may be noted the re-introduction of Physics (Physical Science) in standard VIII and the designation of this

¹⁰Ibid., p. 109.

subject as an option in all high school standards. The restoration of the third year of physical science cannot be taken as necessarily increasing the total program in this subject, however. Under Dr. Goggin's revision of 1902, it may be recalled, students were to cover the material in Merchant and Fessenden's text in standard VI. The 1907 program specified that a revised edition of the same text be completed in standards VI and VII. The authors' preface to their revised edition fails to mention that new topics had been added, so it would seem that appreciably the same amount of material as was formerly in the standard VI program, was now divided between standards VI and VII. This revised edition has been discussed previously.¹¹

Another change in the program was the introduction of a second course in chemistry so that it was now an optional subject in standards VII and VIII. A new text was selected for standard VII, while a textbook written by Ira Remsen, then President of Johns Hopkins University, was approved for use in standard VIII. A general discussion of some of the features of these early chemistry texts follows.

IV. SOME OF THE EARLY TEXTBOOKS IN CHEMISTRY

Waddell's A School Chemistry was the prescribed course in standard VII from 1902 until 1907 at which time it was replaced by Mills' Chemistry for Schools. When a second course in chemistry was added to the high school program at the standard VIII level, the textbook chosen was Remsen's Chemistry, A Briefer Course. (See Appendix D, page 222, for an outline of topics covered in these textbooks.) Not only were these books the first textbooks to be used in provincial high schools, but the latter two also continued in use after the first major revision of

¹¹Supra, pp. 48 - 52.

the Alberta curriculum in 1912. For these reasons some observations on these textbooks and their approach to the study of chemistry are presented in the following paragraphs.

Both Waddell and Mills, whose texts were used in the introductory chemistry course, had reservations about introducing the molecular and atomic hypotheses at the high school level. Mills' reason for so doing, however, seems to have been not so much because of a belief that it was quite unnecessary to account for such things as chemical combination, valence and quantitative results, but rather because he was concerned that it might prove confusing to the student of a beginning course in chemistry. This concern is revealed in the following excerpt:

During the last decade an animated discussion has been carried on in the scientific literature as to the proper place of the atomic and molecular hypotheses in chemistry; and the conviction is rapidly gaining ground that these hypotheses should be excluded altogether from the earlier stages of instruction and should be introduced only after the pupil has acquired familiarity with the fundamental conceptions and quantitative laws of the science. In this way only is it possible to achieve that distinction between fact and hypothesis so long recognized as necessary to clear thinking.¹²

Monroe states that the early objectives in the teaching of chemistry were two-fold, to teach elementary chemistry and to make the science a means of general education.¹³ The early American textbooks such as Remsen's were concerned more with a complete, systematic outline of the subject whereas, in the British texts, the emphasis was more on training in the scientific method.¹⁴

¹²Mills, G. K., Chemistry for Schools. (Toronto: W. J. Gage and Company, 1906). p. 4.

¹³Monroe, Paul (Editor), A Cyclopedia of Education. (New York: The Macmillan Company, 1911). p. 588.

¹⁴Ibid., p. 589.

The concern expressed by Waddell and Mills regarding the dangers of high school students accepting unproven theories would indicate that their textbooks were more in harmony with the British approach to chemistry than the American. The two authors feared that this introduction of hypothetical ideas was premature and would interfere with the development of the scientific habit of thought in the student. So concerned was Mills about this danger that he wrote a separate appendix to his book on the subject of the atomic hypothesis. Because this appendix is somewhat unique, and offers such good illustrations of the reservations and doubts held by some early science educators regarding the advisability of introducing the atomic and molecular hypotheses at the high school level, it has been included in Appendix E, pages 232 - 234.

In this discussion of chemistry textbooks no attempt is made to compare texts of this period with those used in the early Territorial schools because these were found to be no longer available. Comparisons at this point, then, are restricted to textbooks used in the late Territorial and early Provincial high schools. A detailed study of the likenesses and differences among these texts is beyond the scope of the present work. Therefore, only a few of the more notable features of each book are discussed in the following sections.

Waddell's School Chemistry

The first edition of this book, which was the authorized textbook in standard VII from 1902 to 1906, was not available. However, the author's preface to the second edition, published in 1907, stated that no major changes had been made in the newer edition.¹⁵ During the inter-

¹⁵Waddell, J., A School Chemistry, Second Edition. (New York: The Macmillan Company). p. ix.

vening period Waddell commented that he had become "...more convinced than ever that the atomic theory should be relegated to a subordinate place."¹⁶ So firmly did Waddell believe that this theory should not be used in a beginning course, that it was completely unnecessary to account for and explain chemical reactions; and, that the Law of Reciprocal Proportions, for which there existed ample proof, was the preferable basis for explanations of chemical phenomena, that he devoted a special appendix in his second edition to an explanation of how numbers closely approximating atomic weights could be arrived at independently from the concept of atoms.¹⁷ He also avoided the theory of electrolytic dissociation in his first edition. However, in the second edition he somewhat reluctantly appended a discussion of Arrhenius' Theory but maintained, nevertheless, that a consideration of electrolytic dissociation was beyond the scope of a high school chemistry textbook.¹⁸

On his method of presenting the subject of chemistry Waddell wrote:

The interrogatory method has been largely employed; the questions though for the most part simple, are intended to stimulate thought, being calculated to make the pupil observe the important phenomena, see their connections and understand their full significance.¹⁹

The treatment of chemistry in Waddell's book tended to be mainly descriptive with only an introduction to the quantitative aspects of the discipline. The questions posed in the text were asked chiefly in connection with the experiments. The latter were described in the regular context

¹⁶Ibid.

¹⁷Ibid., pp. 275 - 278.

¹⁸Ibid., p. 281.

¹⁹Ibid., p. vii.

and were not set apart in any way, not even by a variation in size or type of print. There were no summaries of important points at the ends of chapters, neither were there problems nor exercises.

Despite his apprehensions regarding the dangers of basing explanations of chemical phenomena on unproven theories, it is of interest to note that Waddell made use of the atomic concepts in his own explanations of valence, chemical bonds, symbols, formulae and the balancing of equations.²⁰

Waddell did not discuss the Periodic Table, although it is obvious from his groupings of the elements, particularly in the last eight chapters, that he made some use of Mendeleeyeff's classification. No mention was made of fluorine in his discussion of the Halogens, nor were the laws of Charles and Boyle mentioned in connection with the study of gases.

In conclusion it may be said that the treatment of chemistry in Waddell's textbook appears to have been quite elementary. His book was definitely written as an introduction to the science and shows, in its emphasis on the distinction between proven fact and unproven theory, a concern for the development of what Waddell considered were proper habits of thought and a sense of scientific inquiry in the student.

Mills' Chemistry for Schools

That Mills, like Waddell, had reservations with respect to using the atomic and molecular hypotheses as the basis for the explanation of chemical phenomena to students at the high school level has already been noted. Another similarity was the erroneous belief that not only

²⁰Ibid., p. 114, also pp. 212 - 214.

did oxygen support the combustion of illuminating gas, but that the latter also supported the combustion of oxygen and the two substances whose roles could be so interchanged were described as being "mutually combustible".²¹ In other respects, however, the approach used in this book was somewhat different from the textbook which it replaced. An example of this difference was the greater prominence given to the quantitative aspects of the subject. Chemistry was described as "...a quantitative science: its systems of classification, its formulae and nearly all its important laws are based on relations between the weights of the substances that enter into the reaction."²² An early chapter was devoted to the concept of the conservation of mass in chemical reactions and this principle was described as the most general of the laws of chemistry and "...the one on which all modern chemistry is based."²³ The gas laws were expressed in the following statement: "The volume of a fixed weight of gas is proportional to the absolute temperature (i.e. the centigrade temperature + 273) and is inversely proportional to the pressure."²⁴ Examples of numerical problems based on these were given in the text and this section of the work was also followed by a set of practice problems for the student.

Mills classified chemical reactions as (a) explosive, (b) non-explosive, (c) reversible and (d) non-reversible. That he did not clearly distinguish between chemical changes and physical changes is indicated by his example of a reversible chemical change as being the melting of ice and the freezing of water.

²¹Mills, G. K., Chemistry for Schools. (Toronto: W. J. Gage and Company, 1906), p. 38.

²²Ibid., p. 42.

²³Ibid.

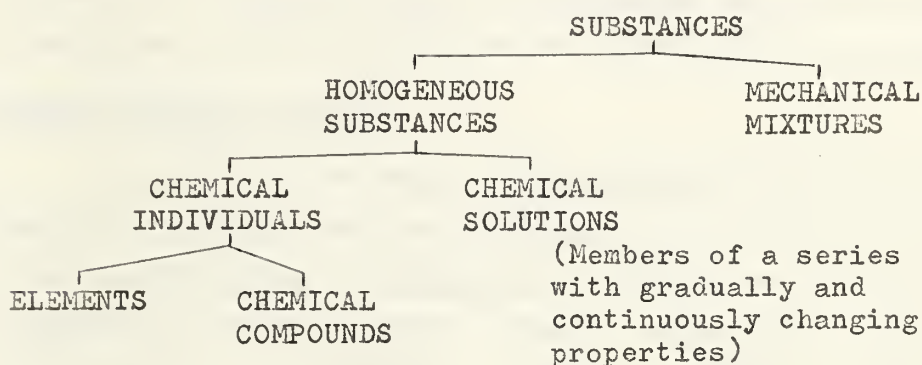
²⁴Ibid., p. 52.

The reaction between hydrochloric acid and sodium hydroxide which Mills said was customarily written as:



could not, he contended, be properly represented as an equation because the substances involved were not chemical individuals but were instead "solutions of chemical individuals."²⁵ No mention was made of either molecules or atoms in the explanation of chemical reactions nor in the explanation of valency which was based entirely on reacting weights.

The classification of substances presented to the student in Chemistry for Schools, together with the meaning of the terms used, may be illustrated as follows:



Mills presented the following explanation of his classification of matter:

Muddy sea water well illustrates the various classes referred to above. In the first place, it is a mechanical mixture of solid particles of sand, clay, etc. with a homogeneous liquid. The solid particles may be chemical individuals or solid solutions. The liquid part may be varied gradually in composition, for instance by evaporation, or by the addition of water and is therefore not a chemical compound. It is said to 'contain' a chemical compound, water, because pure water can

²⁵Ibid., p. 145.

be obtained from it, as also other chemical compounds such as common salt and magnesium sulphate. These substances can be obtained from it by evaporation, and their composition found to be independent of the composition of the liquid from which they are crystallized. That the brine is a solution of these compounds and not a mixture, is proved by the fact that the properties are not those of the pure constituents. (For instance, the pressure with which brine gives off steam, or its vapor tension, at a given temperature, is less than that of pure water at the same temperature.) Moreover, when these salts are brought together with water, a change of temperature takes place, showing that a reaction occurs.²⁶

Although this classification obviously leaves much to be desired when viewed in terms of subsequent knowledge, it nevertheless illustrates that Mills appreciated the usefulness of a classification of substances as an aid in demonstrating both the similarities and differences in matter.

Remsen's Briefer Course

As stated previously, this book was written by the President of Johns Hopkins University, and cited by Monroe in his A Cyclopedia of Education as typical of the American tendency to present a rather complete systematic outline of the subject of chemistry. Remsen described his text as intended for those beginning a study of chemistry.²⁷ Although he began his book with such basic considerations as the distinction between chemical change and physical change, between elements and compounds, and between compounds and mixtures, Remsen's 1909 edition was more advanced than either Waddell or Mills. As an example, like the physicists of the time, he seemed to lack the reservations regarding the introduction of the atomic theory at

²⁶Ibid., pp. 116 - 117.

²⁷Remsen, Ira, Chemistry, Briefer Course. (New York: Henry Holt and Company, 1909), p. v.

the secondary school level. Electrolytic dissociation was unhesitatingly discussed and some emphasis placed on the relations between electrical and chemical phenomena.²⁷

In the latter part of his text, Remsen introduced the concepts of equilibrium reactions and an elementary consideration of the law of mass action. The final chapter in his book was an introduction to qualitative analysis.

The two errors most commonly made in the teaching of science were, in Remsen's opinion:

- 1) the premature presentation of theories that were too advanced because of insufficient background on the part of the student; and
- 2) the giving of directions for experiments to students without first making certain that they understood the reasons for the procedures and the purpose behind the experiment.²⁸

Remsen expressed the opinion that the main objective of science studies was the development of "a scientific habit of thought."²⁹ This objective, he contended, had been achieved only when the student was able to clearly see the relationship of theory to phenomena. Laboratory work, he believed to be indispensable to the study of chemistry, but stressed that the values to be derived from such work required close supervision so that all work was conscientiously and carefully conducted, preferably by the student himself. Where this was not possible Remsen recommended that the teacher perform the experiment, but to no larger a group than ten or twelve students so that all could be involved either by requiring their assistance in some phase

²⁷Ibid., p. iii.

²⁸Ibid., p. 495.

²⁹Ibid., p. v.

of the demonstration or by a system of questioning and cross-questioning during the course of the investigation.³⁰

The chemist, Remsen said, was concerned with the composition of substances. Physical changes he described as those which do not affect the composition of substances, while those changes involving the disappearance of certain substances and the formation of others in their place were defined as chemical changes.

Remsen seemed to have a keen appreciation of the value, in science, of hypotheses and theories and he was not hesitant to point out to the student how useful were these devices to the scientist whose mind had been trained in their uses and limitations. The student was carefully informed that the atomic theory had neither been proved nor disproved, but Remsen nevertheless based his explanation of many phenomena upon this concept of the structure of matter. He contended that Dalton's atomic theory was "the simplest conception that can be formed in regard to the constitution of matter which will satisfactorily account for the laws of definite and multiple proportions."³¹ In the matter of symbols and formulae, Remsen depicted the symbol of an elements as representing two things, namely one atom of the element and also the relative weight of that atom. Arrhenius' theory of ionization was included in the text and a definition of the terms acid and base was given in accordance with the theory of electrolytic dissociation.³² Valence was described as "that property of an element by virtue of which its atom can hold a definite number of other

³⁰Ibid., p. viii.

³¹Ibid., p. 90.

³²Ibid., p. 144.

atoms in combination."³³ Because the chlorine atom and the hydrogen atom each had a holding power of one, it was held that either could be considered an example of the simplest type of atom.³⁴

Remsen presented his discussion of the periodic law before launching into a systematic study of the elements which he grouped according to Mendeleeyeff's table. Although much of this section of the book was descriptive, the processes for the extraction of some of the more common metals from their ores and the reactions involved in the many steps were given in considerable detail and no doubt required a great deal of memorization on the part of the student. The last chapter in this textbook was concerned with introducing the student to qualitative analysis and its application to the study of Groups I and VI in the Periodic Table.

In conclusion it is somewhat of a paradox that despite Remsen's generally more enlightened approach to the subject of chemistry, he, like Mills, believed that oxygen could be burned in an atmosphere of illuminating gas.³⁵

³³Ibid., p. 204.

³⁴Ibid.

³⁵Ibid., p. 243.

CHAPTER VII

THE 1912 REVISION AND THE PERIOD TO 1923

Factors contributing to the first provincial revision of the Alberta curriculum in 1912 and the procedure involved in the process; the revised secondary school curriculum; the new physical science program in grades IX to XII; the program in operation and the adjustments made between 1912 and 1923, are presented in this chapter.

I. THE NEED FOR REVISION

Lack of standards for promotion of students and the resulting inconsistencies in promotion practices, combined with the fact that the amount of work specified in the eight public and high school standards required more than eight years for completion, resulted in requests for revisions to the system for grouping pupils.¹ It will be recalled that when Alberta became a province in 1905 the 1902 curriculum as revised by Dr. Goggin had been retained. Almost a decade had passed since then, and it was felt that there was a need to up-date the curriculum. Another contributing factor was the opinion of University of Alberta faculty members that the preparation of early matriculants entering the university had been inadequate.²

II. FEATURES OF THE REVISION

The reorganization of the method of grouping pupils resulted in a system of twelve grades replacing the older system of eight standards. Theoretically, at least, each

¹Province of Alberta, Department of Education, Annual Report, 1910, passim.

²Supra, p. 56 - 57.

grade was to comprise one year of work for the average pupil and this system of pupil grouping has been largely retained to the present time.

At the high school level, which included grades IX, X, XI and XII, the system of departmental examinations leading to a diploma for successful candidates at the end of each division, was continued. In this way each year of high school successfully completed was recognized as a distinct milestone that for many students would mark the end of their formal education. The physical science programs, together with a list of the obligatory subjects, the optional subjects and the examination subjects in each of the grades IX through XII are set forth in Appendix C, pages 194 - 195. It may be noted that papers were provided in the optional subjects and pupils even at the grade IX level were warned that "...candidates looking forward to university matriculation should take the examination in such languages as their prospective course demands."³

The program as presented in the 1912 revision and which might be termed the first truly provincial program in Alberta, clearly indicated that:

- 1) to qualify for a high school diploma did not require that the candidate meet university matriculation requirements but rather that he comply with the requirements for said diploma as specified from time to time by the Department of Education;
- 2) the requirements for matriculation and entrance to the university would be determined largely by the university and would not necessarily be the same for all faculties.

³Province of Alberta, Department of Education. Annual Report, 1912, p. 151.

Under the chairmanship of Dr. H. M. Tory, President of the University of Alberta, a committee of professional educators including representatives from the Department of Education, the University, the school inspectors, and the teachers, revised this first provincial curriculum. Numerous sub-committees worked over a period of several years and the results of their labours provided the first provincial program of studies which not only outlined the courses and textbooks, but also contained, for the benefit of the teacher, a discussion of methods in the opening paragraphs of each subject.⁴

The high school program adopted in Alberta in 1912 has been described as rather closely resembling the program under the Territorial government in that it was essentially a rather fixed academic type of curriculum.⁵ Another resemblance was a rather imposing number of subjects in each grade. The former practice of beginning the study of physics earlier than chemistry was continued, with some physical science included among the obligatory subjects at each grade level. In grades IX and X this consisted of physics which, along with botany and zoology, made up the course in Elementary Science. In grade IX the physics studied consisted chiefly of such introductory concepts as measurements, mass, density, specific gravity, properties and states of matter, motion, energy and work, molecular theory, pressures in liquids and gases; and saw the introduction of a study of simple machines at the grade IX level. The grade IX, and all subsequent courses in physics involved a review of the previous work in the subject and an extension to include additional concepts. Physics was an option in grade XI, but was made an obligatory subject

⁴Province of Alberta, Department of Education, Annual Report, 1912, p. 49.

⁵Walker, B. E., "Public Secondary Education in Alberta: Organization and Curriculum 1891 - 1951", (Unpublished Doctoral Dissertation, Stanford University, 1955).

at the grade XII level. The program, by requiring three years of physics and providing for a fourth year as an option, may appear to have been rather heavily weighted with physics. An examination of the topics included in the assigned textbooks for study during the four years shows, however, that there was a goodly amount of overlapping of content, especially between the grade XI course and those in grades IX and X. In the grade XII course there was little review of the topics from the grade IX or X program, but if a student had taken the grade XI option in physics he would have had at least an introduction to the four areas of sound, light magnetism and electricity which comprised the grade XII course.

It was definitely specified that the chemistry course in grade XI was to be "...experimental as far as possible",⁶ although what the nature of these "possible" limitations were conceived to be is not clear. The consideration of such basic topics as physical and chemical changes, fundamental principles and laws, and a study of some of the more useful elements and their compounds marks this course as obviously intended to be an introduction to the study of chemistry. It would provide those who were forced to terminate their academic education at the grade XI level, and this included a considerable number of people who would later become holders of the second class teachers' certificate, with at least one course in high school chemistry. Also, it was probably the only chemistry studied by those students not required to take the grade XII course by the faculty under which they proposed to study at the university. Those who were interested only in the grade XII diploma had the choice of taking either the Physical

⁶Province of Alberta, Department of Education, Annual Report, 1912, p. 152.

Science (physics) or Chemistry course in grade XII. Table IV, page 75, indicates the prescribed textbooks in physics and chemistry for the period 1912 to 1923.

It may be noted that the textbook by Merchant and Chant was the first by these co-authors to be authorized for Alberta's high schools. This book and subsequent revisions by these two men were to constitute the prescribed textbooks in high school physics in Alberta for the next twenty-five years. This was one of the most successful achievements by any authors of textbooks in the province's history and one more example of Ontario's influence on the development of the Alberta science curriculum.

III. THE 1912 CURRICULUM IN OPERATION

The excerpts from the reports of the school inspectors appearing in the 1912 Report of the Department of Education, indicate that the new course of studies was generally well received.⁷ The system for grouping pupils into twelve grades rather than eight standards, and the discussion of methods for the teaching of the various subjects appear to have been particularly appreciated by the teachers.

Changes in Chemistry and Physics

With the exception of the adoption of the revised edition of Remsen's chemistry text for grade XII in 1914, the prescribed textbooks and the courses for grades XI and XII chemistry appear to have remained largely unaltered for a number of years. In physics, however, changes were made in both the second and third year the new course of studies was in operation (see Table IV, page 75). In 1914, High School Physics, which had been the text prescribed for grades IX, X and XI, now became the textbook to be used in grades X, XI and XII. It appears that this text may have

⁷Province of Alberta, Department of Education, Annual Report, p. 49 and passim.

TABLE IV

PRESCRIBED TEXTBOOKS FOR CHEMISTRY AND PHYSICS

1912 - 1923

GRADE	1912	1913	1914 - 1923
	PHYSICS	PHYSICS	PHYSICS
IX	<u>High School Physics</u> Merchant & Chant (1911)	<u>High School Physics</u> Merchant & Chant (1911)	<u>Elementary Physics</u> <u>for High Schools</u> (Chap. I - IX) Merchant & Chant (1914)
X	<u>High School Physics</u> Merchant & Chant (1911)	<u>High School Physics</u> Merchant & Chant (1911)	<u>High School Physics</u> Merchant & Chant (1911)
XI	<u>High School Physical Science Part I</u> (Revised) Merchant and Fessenden (1905)	<u>High School Physics</u> Merchant & Chant (1911)	<u>High School Physics</u> Merchant & Chant (1911)
XII	<u>High School Physical Science Part II</u> (Revised) Merchant, F. W. (1906)	<u>High School Physical Science Part II</u> (Revised) Merchant, F. W. (1906)	<u>High School Physics</u> Merchant & Chant (1911)
	CHEMISTRY	CHEMISTRY	CHEMISTRY
XI	<u>Chemistry for</u> <u>Schools</u> Mills, G. K., (1906)	<u>Chemistry for</u> <u>Schools</u> Mills, G. K., (1906)	<u>Chemistry for</u> <u>Schools</u> Mills, G. K., (1906)
XII	<u>Chemistry, Briefer</u> <u>Course</u> Remsen, I., (1906)	<u>Chemistry, Briefer</u> <u>Course</u> Remsen, I., (1906)	<u>Chemistry, Briefer</u> <u>Course (Revised</u> <u>Edition)</u> Remsen, I., (1909)

proven somewhat difficult at the grade IX level, and consequently was gradually advanced to the higher grade levels indicated.

Appendix C, page 196, outlines the physics course according to the prescribed chapters from the authorized textbooks for the school year 1913 - 1914. Since all the chapters from High School Physics are included, it also serves to outline the physics program for grades X, XI and XII from 1914 to 1923. This same appendix (page 201) outlines the text Elementary Physics for High Schools, and provides a list of topics included in the physics course in grade IX during the same period. From this outline it may be concluded that the course, which included an elementary consideration of such concepts as measurement, mechanics of solids, mechanics of fluids, motion, properties of matter and molecular theory, was definitely designed as an introduction to the study of high school physics.

Difficulties in Implementing the Program

Toward the end of World War I, there began a sharp upsurge in the number of students seeking a secondary school education. Among factors contributing to the rapidly increasing high school enrolment were the following:

- 1) The children of those families making up the sudden influx of settlers following the establishment of the province, were now of high school age.⁸
- 2) In many parts of the province settlement was advancing beyond the initial pioneer stage and many parents in these areas desired more advanced education for their children.⁹

⁸Province of Alberta, Department of Education, Annual Report, 1922, p. 15.

⁹Province of Alberta, Department of Education, Annual Report, 1919, p. 69.

- 3) Legislative changes to the School Act raised the age for compulsory attendance from fourteen to fifteen years.¹⁰
- 4) Schools which, in the opinion of educational authorities, were achieving sufficiently high standards, no longer had to require all their students to write Departmental Examinations as the condition of promotion from grades VIII, IX and X.¹¹
- 5) The grant to secondary schools was increased, especially to those districts providing for the instruction of non-resident pupils.¹²
- 6) The economic recession of the early post-war period was particularly severe in agriculture and many of the students of high school age who normally would have left school for other occupations remained because of the lack of employment opportunities.¹³

Early reports of Departmental officials during this period express pleasure with the growing interest in secondary education and the increasing number of students proceeding to high school. While it can be appreciated that this satisfaction probably stemmed from a realization of the benefits to all concerned of an increase in the literacy and general educational level of the population, at the same time, it does not seem to have been fully appreciated that the benefits were to be accompanied by certain very real difficulties. Among these may be listed the following:

- 1) Rural and small village school districts lacked the buildings and equipment, especially laboratory space and science apparatus, necessary to carry out properly the high school program.¹⁴

¹¹Ibid., p. 13.

¹²Ibid., p. 10.

¹³Province of Alberta, Department of Education, Annual Report, 1921, p. 11.

¹⁴Province of Alberta, Department of Education, Annual Report, 1915, p. 21.

- 2) Urban centres, which had previously been adjudged well equipped, were nevertheless lacking the facilities necessary to accommodate properly both resident and the many non-resident students from the surrounding communities who now sought instructions in their high schools.¹⁵
- 3) Because of the adverse effects of the post-war recession on the agricultural economy of the province and because local school boards had such limited sources of revenue, they were unable to provide the necessary buildings, equipment and staff required to meet their needs in secondary education.¹⁶
- 4) Demands for a more varied secondary school curriculum, and the narrow academic program which had sufficed for the previously highly select secondary school population no longer suited the needs and abilities of many of the students then flocking to the high schools.¹⁷
- 5) The majority of teachers in the ungraded schools did not have the training and background necessary to enable them to cope successfully with secondary school instruction, and as a result, their students who were ill-prepared in grades IX and X presented a real problem to the larger schools when they attempted grades XI and XII.¹⁸

From the reports of high school inspectors, something of the conditions in the schools of the period as they struggled along in the face of the foregoing difficulties, is revealed. J. T. Ross, Chief Inspector of Schools for the province in 1916, grouped the high schools into three

¹⁵Province of Alberta, Department of Education, Annual Report, 1922, p. 11.

¹⁶Ibid., p. 15.

¹⁷Province of Alberta, Department of Education, Annual Report, 1920, p. 20.

¹⁸Province of Alberta, Department of Education, Annual Report, 1922, pp. 16 - 17.

classes.¹⁹ The first class was the one-teacher high school, including grades IX, X and XI. He was critical of the science instruction in this type of school and reported that because of inadequate equipment many students had no opportunity to perform experiments, and so tended to study chemistry and physics largely by the process of memorization from textbooks. The second type of school included those in which grades IX, X, XI and XII were taught by a staff of two or three teachers. Typically, this staff included at least one teacher specializing in the mathematics-science pattern. In such schools, the science equipment was usually adequate for teacher demonstration but, with the exception of chemistry, insufficient to enable individual experimentation by students. The third type of school also included grades IX through XII, but was staffed by at least four teachers. Inspector Ross reported favorably on the science program in these schools. The equipment and facilities he found to be modern and the teachers, who were usually specialists in their various fields and also university graduates, were achieving admirable results.²⁰

By the early 1920's however, the high school population explosion alluded to above was beginning to affect the program offered in the schools. Rural boards, in order to reduce the expense of paying non-resident fees for students attending urban high schools, began to require the teachers in their ungraded schools to assume the additional task of teaching grades IX and X. Rather than neglect the younger majority in the lower grades, the teachers tended toward a very limited amount of instruction for the minority of high school pupils in their schools. The inevitable consequence

¹⁹Province of Alberta, Department of Education, Annual Report, 1915, p. 21.

²⁰Ibid., pp. 21 - 22.

was that these students often were ill prepared to cope with the work in grades XI and XII when they enrolled in urban schools.²¹

On the quality of instruction in science in the rural schools attempting the first two high school grades, Inspectors Smith and McKee reported as follows:

In the majority of schools outside the urban centres, the study of the Science subjects is failing to function largely as had been hoped. The laboratory work is reduced to a minimum through the meagre equipment and accommodation provided for this work. In many schools the teacher has not had any special training in Science work and not having gained his scientific knowledge through actual laboratory practice, he is unable with the equipment provided to carry out effectively the required experimental work, nor is he able to bring to his classes practical applications that touch closely on the principles he is teaching.²²

And again, in concluding their discussion of the problems besetting school boards of the day, Inspectors Smith and McKee indicated the importance which they attached to the teacher in these words:

The most difficult administrative problem that the School Boards have to face, and in the presence of which all others seem insignificant, is that of securing properly qualified and trained teachers.²³

That anyone, at either the local or provincial level, concurred in this analysis of the educational problem and was prepared to adopt measures to alleviate the difficulty, is doubtful. No evidence exists that this diagnosis was accepted. Instead, it seems that the consensus of opinion favored a complete reorganization of the curriculum as the means of improving the educational offering and so, for the second time in its young history, the Alberta program of

²¹Province of Alberta, Department of Education, Annual Report, 1922, p. 16.

²²Ibid., p. 17.

²³Ibid.

studies was revised at both the elementary and secondary school level.

CHAPTER VIII

THE 1923 CURRICULUM REVISION AND THE PHYSICAL SCIENCE PROGRAM TO 1935

In contrast to the committee which revised the Alberta program of studies in 1912, the Curriculum Committee of the early 1920's was not composed exclusively of professional educators, but included among its members representatives of a number of lay organizations as well.¹ This chapter outlines some of the new approaches to the construction of a course of study, including greater consideration of the nature and needs of the secondary school population; more emphasis on the aims and purposes of secondary education; and increasing concern about the advantages ascribed to a study of the various subjects. Some high lights of the new course of study; the aims and objectives of science studies; the various science courses, their nature, aims and scope; some features of the new textbooks; the revised program in operation and a brief discussion of the type of examination used, are also presented here.

I. GUIDING PRINCIPLES FOR CURRICULUM REVISION

In its task of revising the program of studies, the revision committee distributed an opinion questionnaire to various organizations and individuals throughout the province and on the basis of the replies received formulated the following set of guiding principles:

1. The new course must be more flexible, i.e. more adaptable to the varying needs of pupils living under widely different conditions and to the limitations imposed by circumstances on boards charged with the responsibility of providing these courses.
2. The number of subjects to be taken concurrently is excessive. It is believed that better results would be obtained by decreasing these and by making a more intensive study of each.

¹Province of Alberta, Department of Education, Annual Report, 1923, p. 12.

3. The committee strongly endorses the suggestion that provincial Departmental examinations be held every year in all subjects. It is believed that this provides the best guarantee that the desired standard is being maintained.²

In its task of building a new course of study the committee seems to have been cognizant of the growing difficulty and complexity of providing young people with appropriate educational experiences. In the introduction to its Second Interim Report issued in March 1923, is found this analysis:

The problem of the organization of a program of studies has become one of very greatly increased difficulty within the past few decades. With the rapid increase in our knowledge of natural phenomena, with the rapid development of the means for the dissemination of such knowledge, with the increasing differentiation in training now demanded by our complex industrial system, and with a growing recognition of the nature and extent of the individual capacities and interests, the arranging of a program of studies which will give due balance to all factors is a serious undertaking.³

Aims and Functions of Secondary Education

The committee also issued a statement expressing its opinions on the aims and functions of secondary education.⁴ No longer was the primary concern of the high school to be restricted to preparation of the student for the economic world and citizenship, as had previously been the case. Henceforth, the objectives were to be broadened to include the student's adjustment to the social standards of his time as well as preparation for his civic responsibilities. Thus, for the first time, curriculum planners were giving formal consideration to providing for the personal development of the student and training for wise use of leisure time.

²Province of Alberta, Department of Education, Annual Report, 1922, p. 25.

³Province of Alberta, Department of Education, Second Interim Report of the Committee on High School Education, 1923, p. 5.

⁴Ibid., pp. 5 - 6.

Objectives and Purposes of Science Studies

The committee ascribed five benefits and objectives from a study of science.⁵ These may be summarized as follows:

1) A minimum knowledge of science was thought to be essential to every citizen in order that he might participate intelligently and effectively in a civilized community.

2) A certain knowledge of secondary school science was held to be a necessary part of the vocational preparation of at least some students.

3) For another segment of the high school population it was preparation for more advanced studies in university.

4) It was suggested that science subjects in common with other courses could be utilized in the development of the scientific habit of thought.

5) Science courses were considered fraught with situations amenable to the development of habits of accuracy in students.

The curriculum writers were under no illusions that the last two values listed would occur automatically, or that they were either peculiar to, or exclusively characteristic of the sciences. These benefits would not be generalized unless a specific effort was made to ensure this. Moreover, it was also recognized that there existed very definite limits on the transfer of training and that whatever did take place, even from one science course to another, would likely be limited to elements that were very nearly identical.⁶

II. FEATURES OF THE NEW COURSE OF STUDY

The following courses (programs) were reported to be in the process of organization: General, Normal Entrance, Agricultural, Commercial, Technical and University Matricu-

⁵Ibid., p. 92.

⁶Ibid.

lation.⁷ Promotion was to be by subject and twenty-one units, exclusive of physical education, were required before the student was considered to have completed the secondary school course leading to junior matriculation or normal entrance and a High School Graduation Diploma.⁸ In all programs except the General Course, about seventy-five per cent of the material was fixed. The requirements for the various courses are included in Appendix C, page 204.

General Science in grade IX was intended as a basic introductory course to all subsequent high school science. Physics was reduced from four years to two; chemistry remained at two years, but agriculture, which now could be substituted for physics and chemistry in the Normal Entrance program, was increased from one to two years.

J. T. Ross, Deputy Minister of Education, describing the recently completed new course of study for high schools said:

The number of subjects studied each year by a student has been materially reduced, and a more extensive and intensive study of each subject is demanded. The number and variety of courses have been increased and boards of trustees in cooperation with teachers must decide what course or courses will be adopted in their schools.⁹

The new course of study was introduced into the high schools of the province on a progressive basis, beginning with grade IX in 1923 and extending to include grades XI and XII by 1925.

The general introduction to the outline of the new science program described three stages in the evolution of

⁷Province of Alberta, Department of Education, Annual Report, 1922, p. 26.

⁸A unit was defined as the amount of material the average pupil could acquire efficiently in 175 - 200 minutes per week during the school year.

⁹Province of Alberta, Department of Education, Annual Report, 1923, p. 13.

high school science teaching.¹⁰ The first, or informational, phase made slight reference to application of scientific principles, little laboratory work characterized the procedures followed and the emphasis was on memorization of facts. In the course of the second phase, described as "...the period of pure science teaching,"¹¹ the pendulum seemed to have swung to the opposite extreme. Science was studied because of its own inherent values, and the development of laboratory technique was emphasized. In the third stage, which the committee apparently considered to be the current phase at the time, the student continued his experimental work, but greater emphasis was placed on learning how to apply his scientific knowledge to everyday problems. Concern was expressed that, at this stage, there was danger that both students and teachers would become progressively engrossed in the application of facts and neglect the basic principles and methods of science. In the words of the committee:

If this were to happen, then we should be in danger of relapsing to the informational phase, the only change being one of content. Whereas formerly we gave pupils a knowledge of principles, rules, formulae and laws, now we are in danger of giving them ready-made explanations of facts, thus inhibiting any tendency on their parts to discover explanations for themselves. In order to prevent this, the courses outlined all call for laboratory and experimental treatment.¹²

The general principles followed by the committee in the selection, arrangement, and content of the courses were: first, a course in general science offered in grade IX which was intended to be at once both introductory and terminal--

¹⁰Province of Alberta, Department of Education, Second Interim Report of the Committee on High School Education. 1923, p. 8.

¹¹Ibid.

¹²Ibid., p. 91.

introductory for those continuing their education, and terminal for those forced to leave school at the end of grade IX; and second, the first course in physics was to be given in grade X, and the first course in chemistry was intended for grade XI, because this was general practice in most school systems at the time.

III. GENERAL SCIENCE I - GRADE IX

This course was avowedly intended as a survey type of course aimed at providing students with a "...broad acquaintance with the field of natural phenomena regarded as a related whole."¹³ It was contrasted to the usual type of high school science course which was so organized and designed that it demanded intensive study of the phenomena and principles in a specialized area. The fact that the course touched on areas from different sciences was held to be evidence that it thus served as an introduction to the narrower, more specialized fields such as chemistry and physics. At the same time it was contended that the topics selected for inclusion in General Science I, were those "...considered of most direct value to the student who may be able to spend only one year in high school."¹⁴

The substitution of a course in general science for the courses previously given in physics, botany and zoology in the first year of high school marked an important milestone in the evolution of Alberta's secondary school physical science program in at least three significant ways:

1. It was the first real attempt at a general survey type of science course.

¹³Province of Alberta, Department of Education, Handbook for Secondary Schools, 1925, p. 140.

¹⁴Ibid.

2. It marked the beginning of an attempt by the province's curriculum builders to construct a program which included among its objectives, efforts to consider differences in interests, needs and personalities among the students.

3. It was the beginning of a trend to build a program of study which was itself an entity, one in which the textbook, though still prominent, was nevertheless auxiliary.

The major divisions comprising General Science I included: (1) Measurement; (2) Air; (3) Water; (4) Life; (5) Energy; (6) Earth's Crust; and (7) The Solar System.¹⁵ In addition to these, and consistent with the first guiding principle which the curriculum committee had established for itself, was a certain degree of flexibility as indicated by the fact that the course could be supplemented by projects closely related to the individual pupil's interests or his local environment.¹⁶

Although the units Life, Earth's Crust and The Solar System lie outside the scope of the term 'physical science' as used herein, the treatment accorded the remaining four units essentially conforms to the concept as set forth on pages 5 and 6 of the present work.

A textbook which met the requirements of the course as prescribed in the program of studies was non-existent. Caldwell and Eikenberry's General Science was authorized, but was soon subjected to wide criticism from teachers because it did not provide coverage of all units prescribed by the program of study.¹⁷ In 1931, M. J. Hilton, then Head of the Science Department, Edmonton Technical School,

¹⁵Ibid.

¹⁶Ibid.

¹⁷Ibid.

published a textbook which he had written specifically for the General Science I course. In preparing the manuscript for his text, Hilton had received help and advice from a number of prominent Alberta educators.¹⁸ The various units of his book conformed exactly to the divisions of the course as outlined in the program of studies.¹⁹ In writing his textbook, Hilton was guided by two criteria, which he described as:

...first, no worth-while science can be taught and learned unless supported by an adequate experimental background; second, ...all junior science work should endeavour to kindle an enthusiasm for the scientific method, and at the same time capitalize educationally the junior student's natural curiosity covering the great phenomena of nature.²⁰

In keeping with these principles, Hilton had attempted to include experiments for which the science equipment commonly found in the typical rural school would suffice, and to write his book in a style that would be found easily readable by the majority of students who would be expected to use it.²¹

IV. CHEMISTRY - GRADES XI AND XII

In contrast to such sciences as meteorology and geology, whose popularity with high school curriculum makers was said to be waning, chemistry was described as a discipline which, along with physics and biology, was retaining its popularity.²² Among reasons cited for this was the

¹⁸Hilton, M. J., A Book of General Science. (Toronto: The Macmillan Company of Canada, 1931), pp. v - vi.

¹⁹Ibid., pp. vii - viii.

²⁰Ibid., p. v.

²¹Ibid.

²²Province of Alberta, Department of Education. Handbook for Secondary Schools, 1925, p. 137.

increasing importance of chemistry to industry, to public health and to certain professions such as medicine. The aims and objectives were said to coincide largely with those of the other sciences, but the teacher was cautioned that in chemistry even more than in other sciences it was necessary to begin with a study of fundamental principles and to build new learnings on these. Chemical processes, it was argued, were comprehensible only after an analysis of the elements. A study of compounding and dissociation could then follow and finally the student was considered ready to "...pass on to the larger fields of inorganic and organic chemistry."²³ The two courses, Chemistry 1 and Chemistry 2, were said to be organized in accordance with the foregoing principles.

Chemistry 1

This was to be a course that introduced students to the fundamental principles of chemistry. The approach was to be largely experimental with individual or group laboratory work occupying a substantial portion of the class time. Through the medium of these experiments, with some of the more familiar elements and compounds, it was anticipated that the student would be led to discover a number of significant fundamental chemical principles. The curriculum for this course is outlined in Appendix C, page 205.

Chemistry 2

Three specific objectives were set forth for the second course in chemistry:

1. to provide the student with a general knowledge of inorganic chemistry and its most significant laws and theories;

²³Ibid.

2. to provide an introduction to the study of organic chemistry; and

3. to acquaint the student with the procedures used in qualitative analysis.²⁴

The study of inorganic chemistry, which was to occupy the major portion of time devoted to Chemistry 2, was to be primarily concerned with those compounds adjudged most significant to daily life. Although the curriculum guide directed that the predominant method of approach was to be experimental, nevertheless, it was also specified that the laboratory work was to be supplemented by discussions designed to familiarize students with the economic and industrial applications of the science.²⁵

A First Book in Chemistry - Bradbury

By the early 1920's the investigations by scientists such as Thomson, Rutherford and Moseley had done much to give scientists confidence in the atomic hypothesis of the structure of matter. This reduction in the hypothetical element of the atomic concept encouraged its increasing use in high school chemistry texts and seems to have played a major role in dispelling any fears, such as those expressed earlier by Mills and Waddell, about the postponing of these more theoretical concepts to higher levels of learning. In any event, Bradbury based his explanations of a number of chemical phenomena on the atomic theory, although his detailed discussion of valence and atomic structure was reserved for the last chapter in his text so that it could be either deleted or designated as supplementary reading should curriculum makers so desire.

Like Remsen's textbook which it replaced, this book was an American text which tended in its treatment of

²⁴Ibid., p. 139.

²⁵Ibid.

chemistry towards a broad survey of the subject. At the end of each chapter was found: (a) a summary of important points; (b) a set of exercises and questions based on the chapter; (c) occasionally, a set of review questions on important laws or principles covered in earlier chapters.

V. PHYSICS - GRADES XI AND XII

The study of high school physics was, henceforth, to be limited to two years rather than four as had been the case under the previous curriculum. The two courses are outlined in Appendix C, pages 207 - 211. From these outlines it can be seen that there was a considerable concentration of the physics program. The content would indicate that the program was indeed a challenge even to the above-average high school student and probably suitable only for the most academically inclined who were preparing for university entrance.

Physics 1

The aim of this course was to ensure that the student obtained a thorough knowledge of the basic principles in physics, at the same time realizing their wide applicability in his own environment. Considerable emphasis was placed on the learning and precise use of the terminology peculiar to the discipline, and careless, incorrect thinking arising from hazy concepts was to be prevented, even if it meant reducing the content as outlined in the course of study.

The inductive approach to the study of physics was suggested by the course of study which proposed to achieve the above objectives by "...directing the attention of the student to well known physical phenomena, and by leading him to interpret his findings in terms of general principles or laws."²⁶ These were to be illustrated experimentally by

²⁶Ibid., p. 152.

individual, group, or class demonstration and each student was to make a written laboratory report. It was suggested that home-made apparatus could frequently be used, that illustrations from other textbooks and magazines would be helpful; at the same time the warning was issued that the program could not be satisfactorily completed without a minimum amount of proper laboratory equipment.

The course of study cautioned teachers that one of the most difficult challenges facing them and their students arose out of the application of mathematics to problem solving in physics. It pointed out that students who could be considered satisfactory in mathematics alone and in the theoretical aspects of physics often failed miserably in the application of mathematics to the solution of physical problems. The recommended procedure for surmounting this difficulty was frequent and accurate repetition, step by step, of what was termed "...the method of scientific thinking."²⁷ This was described as a four-stage procedure involving:

1. isolation of the known facts;
2. determination of the end to be achieved;
3. deciding on the method to be employed; and
4. checking the results obtained.

The Ontario High School Physics, by Merchant and Chant, authorized as the text for Physics 1, was a revised edition of High School Physics, which had been the textbook for all the high school physics courses in the previous curriculum. The greater part of the context was little changed from the earlier edition, the major revision being in those parts dealing with electricity, where the Electron Theory now constituted the basis for the explanation of

²⁷Ibid., p. 152.

electrical phenomena. What was described as "...a modern though brief treatment of radio communication",²⁸ was also added.

Other revisions included the deletion of the historical references and portraits of great scientists; the addition of more problems and question; the revision of a number of diagrams and the addition of many new ones; the inclusion, at the ends of the chapters, lists of elementary reference books.

The chief changes in content were generally designed to bring certain parts of the book up to date with recent technological developments, an example being the addition of sections discussing the Impulse or Pelton Wheel and the Reaction Turbine, to the chapter dealing with applications of the laws of fluids.²⁹

Physics 2

The textbook in this course was Mechanics for the Upper School, by Merchant and Chant. The course included what was modestly described as "...a fairly intensive study of mechanical principles and their application in daily life."³⁰ The experimental and observational approach to a study of mechanics, which was used by the authors of the prescribed text, was to be followed in the schools.³¹ The handbook warned that the new course in mechanics required more than the usual amount of laboratory work customarily

²⁸Merchant, F. W. and Chant, C. A., The Ontario High School Physics. (Toronto: The Copp Clark Company, 1922), p. iii.

²⁹Ibid., p. 125.

³⁰Province of Alberta, Department of Education, Handbook for Secondary Schools, 1925, p. 152.

³¹Merchant, F. W. and Chant, C. A. Mechanics for the Upper School. (Toronto: The Copp Clark Company, 1919), p. iii.

given to high school mechanics and that problem work involving the application of mathematics to physical science was a very important part of the course which should be presented in such a way that students developed an appreciation of the correlation between the two subjects.

VI. THE PROGRAM IN OPERATION, 1925 - 1935

The Years 1925 to 1930

In his report for 1925 High School Inspector J. A. Smith criticized the handling of the new General Science course which, he said, was not functioning at all well. This malfunctioning he attributed to:

1. Lack of proper articulation between elementary and secondary education.
2. The subject being too often regarded as a course that anyone, regardless of training and aptitude, could teach.
3. Failure of teachers to fully appreciate the intent of the course as "...a place of departure into specialized fields of science".³²
4. Emphasis on textbook study, notemaking and a study of diagrams, rather than the experimental approach involving opportunities for students to obtain experiences having greater meaning and significance to them personally.

By contrast, the Inspector expressed complete satisfaction with the grade XII course which he felt was working well because of the flexibility provided in the regulations which permitted the student to select the eight units of work with which he felt most competent to cope, and because suitable textbooks had been selected for each unit of the program.

³²Province of Alberta, Department of Education.
Annual Report, 1925, p. 21.

The new program for high schools was generally found, throughout the province, to be too burdensome for the average student and by 1927 substantial reductions had been made in a number of courses.³³ Significantly none of the physical science courses were included among those subjects whose content had been reduced. At the same time Inspector Fuller reported that the textbook was too much in evidence in science work, and that many small schools were sadly deficient in laboratory space and equipment. On the other hand, he had observed that in many cases where the necessary apparatus was available, it had not been put to maximum use by the teacher. Annual reports of the Department of Education to 1929 continued to make reference to the fact that the provincial high school population was expanding at a rate which exceeded the provision of adequate facilities and properly qualified teachers.

In 1929, following the close of the Legislature, the Minister of Education appointed a Curriculum Review Committee and charged it with three responsibilities as follows:³⁴

1. To determine the advisability of greater limitations to the curriculum then in use.

2. In the event of a decision that further limiting should take place, to determine whether this should be brought about by decreasing the number of subjects, or by reducing the content of existing subjects.

3. To investigate the possibility of establishing uniform requirements for Normal Entrance and Matriculation.

The committee recommended that no decrease should be made in the twenty-one units required for Normal entrance (Junior

³³Province of Alberta, Department of Education. Annual Report, 1927, p. 11.

³⁴Province of Alberta, Department of Education. Annual Report, 1929, pp. 16 - 17.

Matriculation) but they did recommend a number of reductions in the content of various courses. Significantly, the only change made in the high school science program was to make the courses "...more practical through having definite experiments prescribed."³⁵ However, the Department of Education did report that it was striving to find more suitable textbooks in General Science and Chemistry.

High School Inspectors Smith and Fuller reported as follows on the revised science program:

An improvement worthy of notice is taking place in the quality of instruction given in the laboratory sciences, viz., Physics and Chemistry. The revision of the course of study...provided for an increased amount of demonstration by the teacher and a certain amount of experimental work by the students themselves.³⁶

The inspectors expressed general satisfaction with the efforts of both school boards and teachers to comply with the new requirements and expressed the opinion that the reduction in the textbook approach combined with increased use of demonstration and laboratory methods would up-grade the type of graduate produced by the province's secondary schools.³⁷

Resumé of Developments, 1930 to 1935

During this period secondary education in Alberta was characterized by the following:

1. Steady growth in the number of young people seeking a high school education.³⁸
2. An increasing degree of heterogeneity among the

³⁵Ibid., p. 18.

³⁶Ibid., p. 15.

³⁷Ibid.

³⁸Province of Alberta, Department of Education. Annual Report, 1932, p. 9.

secondary school population with respect to abilities, interests and needs.³⁹

3. Lack of adequate buildings, facilities and equipment, especially with respect to the science program.⁴⁰

4. Failure of the multi-track program to develop in the manner envisioned in the 1923 revision.⁴¹

5. A shortage of fully qualified teachers, especially in the rural schools where many were asked to undertake instruction in the first grades of high school.⁴²

In 1934, Dr. H. C. Newland, then Chief Inspector of Schools, commented to the effect that because of the wide range of abilities, interests and personalities found in the high school population, and because of the fact that the majority of these students did not intend to seek further academic training, the greatest problem in secondary education was that of revising the instruction offered in the high schools to meet the individual needs of the province's adolescent population.

Of the type of instruction which he found generally employed in the high schools, Dr. Newland wrote:

In general it may be said that much of the instruction now given in high school subjects encourages students to memorize factual material for reproduction on the final examination, rather than to assimilate ideas for practical use. Not that it is the teachers who are primarily at fault; for it is safe to say that a majority of the high school students have not the requisite mental calibre for mastering the abstract complexities of the purely academic subjects such as Mathematics and Science.⁴³

³⁹Ibid.

⁴⁰Ibid., pp. 55 - 57. See also Annual Report, 1933, p.15.

⁴¹Province of Alberta, Department of Education. Annual Report, 1934, p. 35.

⁴²Province of Alberta, Department of Education. Annual Report, 1932, p. 57.

⁴³Province of Alberta, Department of Education. Annual Report, 1934, p. 35.

The situation was further aggravated by the fact that "...many of the small schools in which the needs of the student could be better served by the commercial, technical or general courses, are offering the straight academic course because it is less expensive."⁴⁴

Another factor contributing to the prevalence of the undesirable type of instruction described by Dr. Newland was the annual Departmental Examinations which all students were required to write.

Although the new program of study called for emphasis on training in the scientific habit of thought and the application of scientific principles to everyday life, the examinations did not reflect this change of emphasis. In fact, they presented the same types of questions as were asked in 1912 - 14. The questions, which were mainly of the essay type requiring the candidate to define, describe, state, give, and did not require scientific deductions from general laws, were instead based directly on the content of the textbook. This form of testing influenced the methods of teaching and learning in the classroom, encouraging the factual approach to knowledge through rote memorization, while neglecting generalizations and the understanding of basic principles.

The 1923 Revision in Retrospect

In review, it may be stated that by 1934 it had become apparent that the high school program, as drawn up by the 1923 committee and amended in 1927 and 1929, was not adequately meeting the requirements for secondary education in the province. In the first place, the multi-track concept providing a choice from among six different courses had never really been fully implemented. The tendency, especially in the smaller centres where the need was greatest, had been

⁴⁴Ibid.

to offer only the more economical matriculation route. Other factors contributing to the difficulties experienced in the operation of the program were: a very severe economic depression; the rapid increase in the number of high school students; the increasing heterogeneity of the student body in terms of interests, abilities and needs; the lack of adequate facilities and equipment, especially for the sciences; unrealistic pupil-teacher ratios particularly in the smaller high schools; a shortage of fully qualified high school teachers in the smaller centres, and finally the control of promotion by means of externally imposed examinations which could be passed by students who had acquired factual knowledge by the process of rote memorization from the textbook.

By 1934 it was evident that minor curriculum adjustments were inadequate and that a major revision was required. A new committee had been organized to consider revising the entire program. The new revisions, which did not begin to affect the program in the high schools until 1936, are the subject of the next chapter.

CHAPTER IX

THE THIRD MAJOR REVISION OF THE ALBERTA CURRICULUM, 1935 - 1940

"Education is not a means to livelihood--
it is a means to life."¹

This modified concept of the role of education; the establishment of the General Committee on the High School Programme; the regrouping of the grades into elementary, intermediate and high school; the restriction of Departmental Examinations to grades IX and XII; provision of a general science elective as an alternative to chemistry and physics; abandonment of the rigid lines delineating the different programs, with the adoption instead of a system of Compulsory and Elective subjects; and a discussion of the physical science courses, textbooks and examinations, comprise this chapter.

I. SOME MAJOR CAUSES OF CHANGE

A number of difficulties encountered in the operation of the 1923 curriculum revision were discussed in the preceding chapter. Comments of leading officials of the Department of Education in the mid-thirties would seem to imply that there were three reasons of particular significance in bringing about the third major revision of the Alberta curriculum. These may be summarized as:

1. modifications in the concept of the role of the school;
2. a general increase in the percentage of the population seeking high school education and increasing heterogeneity of ability, interests and needs;

¹Province of Alberta, Department of Education. Annual Report, 1934, p. 13.

3. the results of research in education, particularly in the period following the Great War.

In 1934 G. W. Gorman, then Deputy Minister of Education, in a section of his annual report in which he discussed courses of study, expressed the opinion that every child should have access to higher learning; that, in the past, education had been too preoccupied with the need for making a living and insufficiently concerned with wise use of leisure time; that the highest motives in education were "...character building and the enjoyment of a full life";² that education was a continuous life-long process of self-development and that it aimed to develop the potentialities of the individual to their fullest at each stage rather than prematurely burdening the child with adult tasks.

Mr. Gorman wrote that the committee then at work on the revision of courses at both the elementary and secondary levels were seeking a new approach in subject matter and method. He stated:

The aim of the school is to develop a habit of study and inclination to practice it. This implies interest. This interest is the germ implanted by the school. Without this germ of potential interest, growth cannot take place. Education is not merely a matter of school years, it is a life process.³

The foregoing statements indicate that changes in the concept of the role of the school were taking place at this time.

The increasing secondary school population and the ever expanding spectrum of abilities, interests, personalities and needs represented therein, has already been mentioned as a major factor contributing to difficulties encountered in the implementation of the 1923 revision. Writing in 1939, Dr. G. Fred McNally, Deputy Minister of Education, reported

²Ibid., p. 13.

³Ibid.

that the secondary school population had more than doubled during the depression years. He ventured the opinion that whereas the second revision had been primarily concerned with modernization of content in the basic subjects, introduction of a wider choice of subjects for non-academic students, and a change in the system of promotion; the circumstances existing in the mid-thirties were such that it had become evident,

...that a more flexible curriculum with a frank recognition of the educational value of the so-called 'practical' subjects and some attempt to study the aptitudes of the pupils, was the next step in programme building.⁴

A third factor contributing significantly to the pressures for change was that almost two decades of educational research, following the Great War, were beginning to produce tangible results in the form of "...modernized subject-matter for school curricula and newer classroom procedures."⁵ An increasing number of improved school books were also appearing on the market at this time. Added to this was a general change in the climate of opinion in the realms of social, economic, and political ideas arising from the trying depression through which the world had been passing.

II. NATURE OF THE CHANGES

In contrast to the previous committee which had included representatives of a great many lay organizations, the membership of the General Committee on the High School Programme, appointed in 1934 by the Honorable Perren Baker, Minister of Education, consisted of professional educators representing the University, the Department of Education,

⁴Province of Alberta, Department of Education, Annual Report, 1939, p. 7.

⁵Province of Alberta, Department of Education, Annual Report, 1938, p. 14.

school inspectors and teachers, with a representative of the Alberta School Trustees' Association providing the only representation of lay opinion. An important addition in 1937 was Dr. O. J. Walker of the University of Alberta who was added to the General Committee on the High School Programme "...in order to give more representation to the Sciences."⁶

In 1934, it was predicted that about seven per cent of the students then in high school would enter Normal Schools and about four per cent would proceed to the University.⁷ Under these circumstances the Committee was concerned with the seemingly insoluble task of providing adequate education for the majority of students who would not pursue their academic education beyond high school, while at the same time ensuring maintenance of the standards of scholarship required by those seeking entrance to institutions of higher learning.

One of the first decisions reached by the Committee was that the new program for grade IX should be more closely integrated with those of grades VII and VIII. Consequently, the organization of the school grades was revised so that henceforth, there were to be three distinct divisions: (a) elementary, comprising grades I to VI; (b) intermediate, consisting of grades VII to IX; and (c) high school, which included grades X to XII. Thus, grade IX was removed from the senior group of grades in the province's school system and as a consequence, science studies at that level no longer come within the scope of the present study.

Another major change concerned the system of Departmental examinations. Henceforth, entrance to and graduation

⁶Province of Alberta, Department of Education, Annual Report, 1937, p. 19.

⁷Province of Alberta, Department of Education, Annual Report, 1934, p. 34.

from high school would be controlled by examinations administered by the Department of Education in grades IX and XII respectively, but there were to be no Departmental Examinations at the end of grade X or grade XI.

In all of the senior high school grades, promotion was to be by subject or unit, on recommendation of the principal in grades X and XI, but on the basis of achievement on Departmental examinations in each subject in grade XII.⁸

The grade IX examination which was to be, in effect, the high school entrance examination, was under the jurisdiction of the province's High School Entrance Examination Board. Promotion was not by subject, or unit, but on the basis of over-all achievement. Should a student fail, he was required to repeat the entire grade. However, two types of pass were established: (a) the unrestricted pass, which entitled the candidate to register in the first year of the program of his choice in high school; and (b) the restricted pass, which prevented the candidate from registering in certain of the academic electives during his first year of high school. Chemistry I and Physics I were included among these electives. Should a candidate fail to receive an unrestricted pass from grade IX, he was required to register in General Science I, or Biology I, or Geology I in grade X. Then, on condition that he achieve satisfactory results in one of these courses, he was permitted to register in the first unit of one of the academic sciences.

The Reorganization of High School Subjects

The revised grade X program was introduced into the province's high schools in September, 1937, the grade XI program followed in September, 1938, and reorganization was

⁸Province of Alberta, Department of Education, Annual Report, 1936, p. 14.

completed with the introduction of the revised grade XII program in the fall of 1939. Under the new organization the sharp lines of demarcation among the various programs such as academic, technical, commercial, and so on, were removed and two broad categories of subjects were established, viz. Compulsory and Elective. Subjects listed under the first heading were required of all students, and included Health and Physical Education 1 in grade X and English and Social Studies in each of the three high school grades. The electives were organized into four categories: Academic, Commercial, Technical and General. Chemistry and physics were included among the academic electives and were required for matriculation.

III. THE REVISED PROGRAM IN HIGH SCHOOL SCIENCE

In 1935, E. L. Fuller, Chief Inspector of Schools, reported that chemistry and physics were being taught in many schools and that the optional courses in agriculture had been eliminated. He cited two reasons for this trend:

1. Even young farm people seemed to consider that physics and chemistry provided a knowledge and understanding of principles of greater value to them than a textbook knowledge of agriculture.
2. In many schools the change appeared to have been inspired by the requirements for Matriculation and Normal School Entrance.⁹

The elimination of courses in agriculture became official when they were deleted from the list of high school subjects under the revised program of 1937 to 1939. However, since the academic sciences of physics and chemistry were considered to be beyond the range of interests and abilities of the majority of students and since studies in science were considered to be an essential part of general education,

⁹Province of Alberta, Department of Education, Annual Report, 1935, p. 42.

two new courses, entitled General Science 1 and General Science 2, were devised.

High School General Science

It was anticipated by the curriculum planners that the majority of students not seeking matriculation would elect the courses in general science which were designed to "...cut across the traditional subject matter fields of the physical and biological sciences..."¹⁰ and were intended to be integral parts of a system of general education--a system in which "...the content and methods of teaching are chosen because of their significance for human living."¹¹ The objective of the courses in general science was to be consumer knowledge and protection in an industrial society that was becoming increasingly complex. The difference in approach and emphasis in laboratory work between these courses and the more traditional science courses such as physics and chemistry are set forth in the following excerpt:

The laboratory should be a place where the pupil can pursue truth in the manner of the scientist. In science courses, experimental work has been emphasized because of its relation to the 'scientific method', also because it provides pupil activity. In general education, the scientist accepts proven laws without verification and expends energy on uses he can make of the generalizations. Laboratory experiments are useless unless performed with a purpose in view and definite outcomes in mind. The experiment must function in the life of the pupil. Such work should embody the spirit of problem-solving as a teaching method. Evidence should be gathered and observations should be recorded faithfully. The laboratory should be a place where pupils can find answers to questions and not merely verify the textbook descriptions...

¹⁰ Province of Alberta, Department of Education.
Program of Studies for the High School, Bulletin IV, 1939
p. 26.

¹¹ Ibid.

Finally, pupils should learn to recognize the ways in which science enters into human affairs and the contribution it has made to our civilization. The scientific method, once mastered, gives one a way of thinking that can be applied to all walks of life. Pupils from their studies should be able to formulate a large number of generalized insights.¹²

Chemistry 1

The revisions to Chemistry 1 included a new textbook, New Practical Chemistry, by Black and Conant, which was accompanied by a laboratory manual and a reference manual for the teacher's use. The textbook material was apparently considered to constitute such an appropriate course in introductory chemistry that the curriculum guide merely stated, "...this course is as outlined in the textbook. Laboratory demonstration and practical work is required. Chapter 14 is optional. Chapter 22 is to be omitted."¹³ The table of contents from this book has, therefore, been included in Appendix D, page 223.

In the preface to their text, the authors contended that they had tried to make the study of chemistry both vital and practical by suggesting many experiments for demonstration by the teacher, by including only those theories, facts and laws which could be considered essential knowledge for a well-informed citizen, and by limiting their discussion of modern theories on the structure of matter to the minimum essential for clarity and understanding of the fundamental concepts.

Although the material outlined in the textbook constituted a substantial course in chemistry for the time available, there appears to have been a definite attempt

¹²Ibid., pp. 26 - 27.

¹³Ibid., p. 24.

to limit the discussion of various topics. As an example, the authors stated:

We have arranged the material on metals with a view to emphasizing the general processes of metallurgy and the real uses of the metals in modern life. We have consistently avoided an encyclopedic compiling of more or less useful information about their extraction, properties, uses and compounds.¹⁴

To assist the teacher in organizing the course and in making some provision for the wide range of interests, abilities and needs of students, the textbook contained five groups of special review questions (see Appendix D, page 223). Moreover, each chapter ended with a summary of important points covered and a set of review questions which were usually organized into three groups: easy questions on basic principles, more advanced questions, and numerical exercises.¹⁵

Comparing the content of this course to the previous introductory high school chemistry course, the deletion of the solubility curve, the limiting of the discussion on metallurgy, and the limiting of the section on deliquescence and efflorescence in the study of water of crystallization, may be noted. The revisions to the Chemistry 1 course at this time were, however, of a minor nature involving mainly a different approach in presentation through the new textbook and a change in emphasis--the stressing of the practical benefits of a study of chemistry.

Chemistry 2

As early as 1933 it was reported that selected grade XII classes were experimenting with a new text by

¹⁴Black, N. H. and Conant, J. B., New Practical Chemistry, Book One. (Toronto: The Macmillan Company of Canada, 1937), p. vi.

¹⁵Ibid.

Littler.¹⁶ Apparently, experience with these classes may have resulted in suggestions for certain changes, because a second edition of this book, entitled Elementary Chemistry Book II, was published in 1934 and became the authorized text in Chemistry 2. Available records do not make clear in just which year the change in textbooks was made, but it appears to have been before the general revision of the high school curriculum in the period 1937 to 1939.

Neither the preface to this textbook nor the brief references to it in the reports of the Department of Education, mention particular efforts to modernize the content. However, certain concepts, especially those dealing with the structure of the atom, were brought up to date and reference to the universal ether, either in the discussion of gamma rays or elsewhere in the text, was omitted. Some other differences between this book and the former text were:

1. Elementary Chemistry Book II was designed exclusively as a textbook for a second course in chemistry; Bradbury's, A First Book in Chemistry, was not.

2. Bradbury, in his text published in 1922, had included plates which illustrated many war scenes, munitions plants and other wartime industries, whereas Littler omitted these somewhat contentious items and chose, instead, illustrations drawn chiefly from Canadian industries and natural resources.

3. Littler expressed the opinion that "...most teachers are agreed that the quantitative side of the subject should be kept constantly in view..."¹⁷ and consequently, he attempted to include a few problems among the questions with which he ended each chapter.

¹⁶Province of Alberta, Department of Education. Annual Report, 1933, p. 18.

¹⁷Littler, W., Elementary Chemistry. (Toronto: Clarke, Irwin and Company, 1940), p. vi.

In his treatment of the subject of chemistry generally, Littler attempted to maintain a balance between the basic, theoretical principles of the subject and their practical applications in the daily life of the student.

The program of study began its outline of the grade XII chemistry course with some specific requirements:¹⁸

1. That this course should only be offered in those schools where the instructor has Chemistry 2 or its equivalent and where the laboratory equipment is adequate for all of the prescribed experiments.

2. Some sections of the text were to be regarded as required reading but not required classroom material. (See Appendix D, pages 224 - 225.)

3. That the laboratory experiments were grouped into three categories: (a) those to be teacher demonstrated; (b) those to be either teacher demonstrated or performed by all students, at the discretion of the teacher; and (c) those to be conducted by the students. Some thirty periods in the laboratory were to be required of each student, but experiments performed in groups of two were to be considered as individual work. The teacher was required to certify that his students had performed the experiments outlined in the authorized manual and to assign each student a mark in this section of the course.

4. To determine the student's final mark in Chemistry 2, eighty-five per cent was to be based on the written Departmental examination and the remaining fifteen per cent on the laboratory work performed by the student.

Physics 1

The courses in both Physics 1 and Physics 2 were outlined in the program of studies by reference to sections

¹⁸Province of Alberta, Department of Education.
Program of Studies for the High School, Bulletin IV, 1939,
 p. 26.

of the authorized text, Elements of Physics for Canadian Schools (See Appendix D, pages 226 - 228.)

Teachers were admonished to make this course as practical as possible by means of laboratory experiments and other activities in the classroom which would relate the subject to the student's daily experiences. The areas included in Physics 1 comprised: (a) An Introduction to Physics; (b) Mechanics of Fluids; (c) Mechanics of Solids; (d) Some Properties of Matter; (e) Sound; and (f) Light.

Physics 2

Physics 2 included a study of: (a) Heat; (b) Magnetism; (c) Electricity; and (d) Other Forms of Radiant Energy. Experimental work, both demonstrations by the instructor, and individual or small group experiments by the students, was considered a fundamental method of approach rather than extensive exposition from the textbook. To this end, the curriculum guide specified that every student was required to participate in the performance of at least fifteen experiments and to make suitable written reports on these laboratory exercises.¹⁹

Part IX of the text which comprised the section of the course dealing with radiant energy, did not require exhaustive treatment in the classroom. The teacher was permitted to use his discretion in adapting teaching procedures and matters of detail to the aptitudes and needs of his class; but it was suggested that individual pupils, having special interests and abilities, could, for this section, prepare reports and give demonstrations. Mastery of the content in this unit was not required for the Departmental Examination.

¹⁹Ibid., p. 69.

Elements of Physics for Canadian Schools--Merchant and Chant

The original edition of this work, first published in 1911 as The Ontario High School Physics, was selected as the authorized text in high school physics following the 1912 revision of the Alberta curriculum. A second edition, published in 1923, was again chosen as the physics textbook in Alberta high schools following the second major revision begun in that same year. In 1928 the title was changed to Elements of Physics, but since there were only minor revisions, consisting chiefly of form and arrangement, it appears that the Alberta Department of Education did not consider a new authorization necessary and the 1923 version continued as the prescribed textbook until 1937. In that year the book was revised and entitled, Elements of Physics for Canadian Schools. Among the features of the new work, claimed by its authors in their preface, were:²⁰

1. A revision of illustrations and plates to include more illustrations of Canada and Canadian industries.

2. A thorough revision involving the deletion of certain topics and the addition of others, particularly in the sections dealing with electricity and sound.

3. A shortening of the chapters, an increase in their number, and a change in the order in which the different branches of physics were treated, were revisions resulting from the authors' own experiences in the classroom.

While it may be conceded that the textbook had been improved in appearance and organization, a close comparison of this edition with its predecessor, The Ontario High School Physics, fails to reveal what might properly be termed a major revision of content. This is particularly true of

²⁰Merchant, F. W. and Chant, C. A., Elements of Physics for Canadian Schools, New Edition. (Toronto: The Copp Clark Company, 1937), p. iii.

the first eight sections of the book which comprised the greater part of the Alberta high school physics program. Many of the additions to the text concerned Part IX entitled, Other Forms of Radiant Energy, which, as has already been noted, was not required material for purposes of the grade XII Departmental Examination.²¹ In this section, additions were concerned chiefly with radio transmission and reception and a description of the photo-electric cell which was described as an essential component in television. By contrast, an example of the authors' failure to introduce either a different approach or new material, would be the treatment of sound. Detailed examination of the presentation of this topic in the two books shows them to be virtually identical.

The lack of change in the treatment of many topics may be offered as a criticism of Elements of Physics for Canadian Schools. On the other hand, it could be argued that there had been little change in many basic principles related to the topics discussed in this text. Added to this was the fact that Merchant and Chant's previous textbooks had proved satisfactory; they had been popular in several provinces; and it may be well appreciated that the authors were reluctant to alter drastically that which had been so successful.

Examinations

By 1939 the new program of study was in operation throughout all high school grades and the changes in philosophy and approach to the study of physics and chemistry began to be reflected in changes in the type of examination set for grade XII students by the High School and University Matriculation Examination Board. Among these changes was an increase in variety and number of questions asked.

²¹Supra, p. 112.

The newer techniques of examining which attempted to measure "...all-round growth and development of pupils rather than their ability to reproduce memorized but meaningless facts",²² were utilized in setting many questions on the papers. These techniques involved the use of multiple choice questions, short answer completion type questions, use of diagrams in questions, the selection of correct conclusions from stated facts, and the application of basic principles to new situations.

Typically, the examination paper consisted of two parts: Section A, which included a large number, about fifty, short answer questions; and Section B, which consisted of questions more like those on the older type of examination involving some problem work and written descriptions. The increased number of questions was accompanied by an increase in the number of marks. No longer was the possible raw score set at 100 marks, but frequently was 160 or more and candidates were informed that it was unlikely they would be able to answer all the questions in the allotted time.

The intent of officials in adopting the new type of examination is well expressed in the following comment by Dr. H. C. Newland, Supervisor of Schools for the Province:

Since Departmental examinations have always produced a well-marked effect on classroom teaching and procedures, the recent changes in style and tenor of these examinations should improve materially the prevailing quality of classroom instruction in English, Social Studies, Science, Mathematics and Foreign Languages. What these examinations aim to test is not the student's ability to reproduce memorized or specially prepared material, but to apply principles in new situations and to think independently--in other words democratically.²³

²²Province of Alberta, Department of Education, Annual Report, 1937, p. 19.

²³Province of Alberta, Department of Education, Annual Report, 1940, p. 18.

There seems little reason to doubt that the newer type of examination measured certain aspects of growth and learning which the older type did not. There is even less evidence that rote memorization of course content by the student would not have enabled him to cope successfully with the newer type of examination or, that these examinations necessitated changes in the methods of instruction.

CHAPTER X

THE THIRD REVISION IN OPERATION IN THE PERIOD 1940 - 1952

Criticisms of the third revision; the failure of the general science courses, new textbooks by Jaffe and Dull; the organization of the Curriculum Branch; the fourth revision, 1950 and its new concept of science education, comprise this chapter.

In 1939, Dr. Newland reported that since program changes were under way throughout Canada and the United States which could be implemented only gradually, because of administrative considerations, it was necessary to consider curriculum revision as a continuous process. To provide means whereby the Alberta program could be under constant review, a standing Core Committee was established which was to be supplemented by three committees--one for each high school grade.¹

I. CRITICISMS OF THE THIRD REVISION

Critics of the revised program for the high school claimed it had caused a lowering of achievement standards in certain academic subjects. Dr. H. C. Newland, in answering this charge, conceded that with the much larger high school population, involving a wider range of abilities, the same standards could not be attained as with a select group. However, he defended the reasoning behind the revision by saying:

...With a rigid programme, dominated by academic subjects, only two results were possible: either the standard of achievement was lowered or a larger number of students--almost a majority--was habituated and enured to failure. With the revised programme

¹Province of Alberta, Department of Education, Annual Report, 1939, p. 17.

students can be graduated from the high school without failure if they elect subjects proper to their aptitudes and interests...²

There seemed to be a discrepancy between what had been planned and what was, in fact, taking place in the schools. Dr. Newland, in his analysis of existing conditions, wrote:

Nevertheless it must be said that impoverished conditions and economic pressure tend to drive students towards the academic electives; both because these subjects are still generally regarded, in our competitive society, as subjects that confer status and prestige; and because they can be used by employers as criteria for the selection of applicants for 'white-collar' jobs. In this way the growth of ability in Mathematics and Science may have much more importance in the eyes of the public than the development of a wholesome personality. The relation of this untoward symptom to education for democracy should not be overlooked.³

II. CONTINUED DOMINATION OF THE ACADEMIC SCIENCE ELECTIVES AND FAILURE OF THE GENERAL SCIENCE COURSES

Although the courses in General Science 1 and 2 had been planned to meet the needs of the majority of high school students, they failed to divert more than a minority to the more general pattern of education. By 1948, General Science 1 was offered in only fourteen of the non-urban schools and only two classes of General Science 2 were offered throughout the province other than in urban high schools.⁴

In addition to the reasons already cited by Dr. Newland for the failure of the general courses to function

²Province of Alberta, Department of Education, Annual Report, 1940, p. 17.

³Ibid.

⁴Province of Alberta, Department of Education, Annual Report, 1948, p. 47.

as planned, a number of other reasons for the lack of appeal of the courses in general science are contained in the Annual Reports of the Department of Education. Among these were:

1. Emphasis was placed on a study of physics and chemistry by the Armed Services.⁵

2. These courses were not recognized as credit toward either Normal School Entrance or Matriculation.⁶

3. There was a lack of available instruction time, particularly in the smaller high schools.⁷

4. Most of the students entering high school on a restricted pass chose Geology 1 or Biology 1 in preference to General Science, as the means for qualifying for entry into the academic pattern.⁸

5. Lack of a textbook in either of the general science courses made them unpopular with students and teachers.⁹ For these reasons, the majority of the secondary school population continued to select chemistry and physics as science electives.

In the late 1930's and early 1940's, as the country recovered from the economic depression and the rural school districts were reorganized into larger administrative units, a general improvement in the equipment and facilities for laboratory work in physics and chemistry was reported. However, the type of instruction offered in the small high schools

⁵Province of Alberta, Department of Education, Annual Report, 1942, p. 70.

⁶Ibid.

⁷Province of Alberta, Department of Education, Annual Report, 1943, p. 28.

⁸Province of Alberta, Department of Education, Annual Report, 1947, p. 44.

⁹Province of Alberta, Department of Education, Annual Report, 1948, p. 47.

was not approved by the school superintendents who described the work as predominantly academic. Theoretically, the non-academic electives were offered, but the limitations of time, even when the instructor had the necessary qualifications, meant putting these aside in favor of the academic courses although ninety-five per cent of the students in such schools would never enter university.¹⁰ The academic courses also suffered from lack of instruction time. About eighty-five per cent of the standard teaching time was all that could possibly be afforded, necessitating a study of minimum essentials and the reduction of such enrichment activities as discussion, individual laboratory work and the pursuit of projects of special interest.

The Program in Physics and Chemistry

The High School and University Matriculation Examination Board recommended, in 1942, that the laboratory work in physics, chemistry and biology be regarded as an integral part of these courses and that candidates, therefore, should be given a single rating in each subject rather than separate grades in theory and laboratory work.¹¹ Subsequently, the practice of basing a candidate's final Chemistry 2 mark, fifteen per cent on laboratory work and eighty-five per cent on the Departmental Examination, was to be discontinued.

In the matter of textbooks and course content it was reported, in 1937, that the course in Chemistry 1, as contained in New Practical Chemistry, was being subjected to criticism as being too long and overlapping the course in Chemistry 2.¹² However, this criticism seems to have been

¹⁰Province of Alberta, Department of Education, Annual Report, 1943, p. 28.

¹¹Province of Alberta, Department of Education, Annual Report, 1942, p. 32.

¹²Province of Alberta, Department of Education, Annual Report, 1937, p. 47.

dispelled by explaining that the Chemistry 1 course was not prescriptive; that there was no longer a Departmental Examination in the course; and, that since the outline was suggestive only, the individual teacher should feel free to select, from among the proposed activities, those which were best suited to the needs of his class in the time available.

By 1938, the inspectors reported that the new texts in physics and chemistry had contributed towards improved teaching of these subjects and that classes were devoting more time to observation, demonstration and experimentation than in previous years.

The reports of the high school inspectors, in the late 1930's and early 1940's, express general satisfaction with the teaching of physics and chemistry under the new program of studies and by 1942 it was noted that these two subjects had received "...a notable stimulus from the emphasis placed on these subjects by the Armed Services."¹³ The fact that some of the best teachers had left the classroom for the armed forces did, however, reduce these favorable effects to some degree.

By 1942, nine years had elapsed since the publishing of Littler's Elementary Chemistry, Book II, and there began an appeal by teachers for a more up-to-date textbook for Chemistry 2.¹⁴ This request was met in 1944 when new textbooks were adopted for use in both Chemistry 2, and Physics 1 and 2. At the same time the Department issued Bulletin B, containing an outline of the practical and experimental work in Chemistry 2 and Physics 2, and a list of suggested references recommended for every classroom library.¹⁵

¹³Ibid., p. 70.

¹⁴Ibid.

¹⁵Province of Alberta, Department of Education, Program of Studies for the High School, Bulletin B, 1944.

The Forward to Bulletin B stipulated that the laboratory work was not to be regarded as an entity, separate and distinct from the theory and concerned primarily with the training of research specialists. It was to be regarded instead as an integral part of these courses, which had been included to facilitate and augment the teaching of the theory "...and provide along with other activities, some meaningful experience for the student that may facilitate his comprehension."¹⁶ Accordingly, teachers were directed to synchronize the laboratory work with other instruction.

The practical work for Chemistry 2 and Physics 2, as outlined in Bulletin B, was to be regarded as suggestive rather than prescriptive in both courses. In physics a major change was the transference of the study of Machines, Work, Energy, Power, Force and Motion from Physics 1 to Physics 2. The program in Physics 1 and 2, as well as that in Chemistry 2, were outlined by reference to certain chapters in the prescribed texts. These may be found in Appendix D, pages 229 - 231.

The changes in physics and chemistry at this time would seem to imply a broadening of the objectives of these subjects. The learning and appreciation of the scientific method had been a feature of these courses, emphasized by the program of study since the 1923 revision. Now, a definite effort seems to have been made to have students learn how to apply this method as a means of problem-solving by encouraging them to use it in their study of these two subjects. This approach is apparent not only in statements appearing in Departmental publications relating to these courses, but also in the books which were selected for authorization as prescribed texts.

¹⁶Ibid., p. 3.

Jaffe's New World of Chemistry

This book was written from the point of view that the college-preparatory function of high school science was no longer the major concern. Jaffe contended that:

Science teaching can and should focus its attention on the development of well-adjusted, well-informed, and intelligent boys and girls...who will be citizens tomorrow, participating citizens of a democracy in which the method of science is used in solving not only the problems in science but also the problems of society.¹⁷

To provide for individual differences in abilities and interests, Jaffe concluded each chapter of his text with a variety of materials including a summary, a set of exercises graduated in difficulty, a list of recommended readings and a group of projects designed to provide students with an opportunity to apply the scientific method. In an effort to make his book more appealing to students, he attempted to employ a clear, concise style in a vocabulary of common words and to integrate significant historical developments with the content material so that in acquiring a mastery of the content, the student would gain an appreciation of the development of fundamental scientific principles.¹⁸

Explanations of chemical phenomena were all said to be based upon, or related to, the laws pertaining to the conservation of mass and energy and the theories concerning ionization and the electron structure of matter.¹⁹ Jaffe expressed the opinion that his use of historical references would help the student appreciate the part played by science in the evolution of modern civilization, learn how scientific

¹⁷Jaffe, Bernard, New World of Chemistry. (New York: Silver Burdett Company, 1942), p. v.

¹⁸Ibid., pp. vi - vii.

¹⁹Ibid., p. vi.

discoveries affect society and, conversely, how the needs of society have stimulated scientific research.²⁰

Modern Physics--Dull

Much of what has just been said about vocabulary, simplicity of language, and the involvement of the historical aspects of science by Jaffe would apply similarly to Modern Physics. Dull introduced each unit of his book with a preview, in which he typically gave a brief historical summary of the topic and led up to its significance and practical application in modern society. His approach to physics involved a four-step procedure as follows:²¹

1) The topic was stated or question posed.

2) An incident or device familiar to most pupils was used as an introduction.

3) The physical principle was then discussed and explained in simple terms.

4) The manner in which the principle is applied was illustrated in one or more practical applications.

Dull reasoned that:

Such a method arouses interest by its inductive approach; it is understandable because of its simplicity; it links the principle with the pupil's former experiences; it is practical because it introduces many appliances which the pupil meets from day to day.²²

At the beginning of each chapter there was a glossary of new terms defined in rather simple language. The following are examples:

Matter, anything that takes up room.
Density, weight per unit volume.
Force, a push or a pull.²³

²⁰ Ibid.

²¹ Dull, Charles E., Modern Physics. (Toronto: Clarke, Irwin and Company, 1945), p. iii.

²² Ibid.

²³ Ibid., p. 3.

Each chapter in Modern Physics was summarized and the last part of the summary usually included a list of terms which the student was invited to explain or define. Dull used an analytical approach to problem solving by first carefully explaining each new type of problem, then following this explanation with a simple solution. However, he also included formulae for those who prefer to use the formula method of problem solving. Each chapter was typically concluded with exercises comprised of a set of questions and a set of problems. The latter was usually divided into two groups: the first intended for the average pupil, and the second for the superior student.

The new textbooks in chemistry and physics seemed to have proved generally acceptable in the province's high schools, as indicated by the following statement from the consolidated report of the high school inspectors:

The courses in Physics and Chemistry appear to be generally satisfactory. Sporadic complaints re inaccuracies in the Physics text were received, but most teachers agree that the book has many admirable features which more than compensate for these errors.²⁴

III. ORGANIZATION OF THE CURRICULUM BRANCH OF THE DEPARTMENT OF EDUCATION

In 1945, the Department of Education was reorganized and the Curriculum Branch assumed the curricular responsibilities related to courses of study, textbooks and supervision of examination procedures which had formerly been assumed by the Supervisor of Schools.²⁵ By this action the Province had finally established the necessary organization to provide continuous study and review of the Alberta

²⁴Province of Alberta, Department of Education, Annual Report, 1947, p. 44.

²⁵Province of Alberta, Department of Education, Annual Report, 1945, p. 37.

curriculum. In 1946, Bulletin 5a, outlining the prescribed courses in physics and chemistry, was issued by the newly established Curriculum Branch. This publication acknowledged that facilities for science instruction would vary from school to school; but it outlined certain minimum requirements for the science room and the science library, discussed visual aids, stressed the importance of English in all science courses and stated that "...one of the objectives of good science teaching is the stimulation of the use of reference material."²⁶

Conditions in the Schools at This Time

The shortage of high school teachers, the general dissatisfaction of superintendents and inspectors with the small high school, and improvements in the province's roads, contributed to a trend toward centralization of high schools in Alberta in the period following World War II. By 1946, it was reported that although laboratory equipment was reasonably adequate for the courses in chemistry and physics, many urban high schools were becoming overcrowded and finding themselves with inadequate classroom and laboratory space because of large numbers of pupils being transported from rural areas.²⁷

Matriculation courses continued to set the pattern of the programs elected by the majority of high school students. General Science 1 was reported as seldom offered and General Science 2 was confined to the urban centres, for the reasons previously cited.²⁸ By 1950, it was suggested that the impetus given to interest in Alberta's geology by

²⁶Province of Alberta, Department of Education, Program of Studies for High Schools, Bulletin 5a, 1946, p. 3.

²⁷Province of Alberta, Department of Education, Annual Report, 1946, p. 34.

²⁸Supra, pp. 118 - 119.

the extensive discoveries of petroleum might make this an opportune time for the development of geological studies at the high school level.²⁹

In this period, from 1947 to 1952, the High School Inspectors repeatedly expressed dissatisfaction with progress in the practical or laboratory work in chemistry and physics. H. C. Sweet has consolidated their opinions in the following words:

In the majority of classes the academic sciences of physics and chemistry are taught as organized bodies of information with the fundamental disciplines of the scientific method unduly minimized. Experimentation is mainly for the purpose of verifying the principle that has been learned by rote.³⁰

The inspectors felt that lack of teaching time limited the experimental work and necessitated a textbook approach in the smaller schools, but suggested that experimental work could be expanded in the larger centres. General satisfaction with the teaching techniques and the laboratory work was expressed by 1951, but two specific criticisms were reiterated:

...too much rote experimentation occurs;
...too little time is spent upon generalizations and principles arising from knowledge of the facts of science.³¹

IV. CURRICULUM REVISION 1950 - 1952

The need for a revision at this time was twofold: there was a measure of dissatisfaction with the program as it was operating, and there was a realization of the necessity for continuing review and revision to keep pace with scientific and educational developments.

²⁹Province of Alberta, Department of Education, Annual Report, 1950, p. 39.

³⁰Ibid., p. 40.

³¹Province of Alberta, Department of Education, Annual Report, 1951, p. 46.

In the Curriculum Guide for Alberta Secondary Schools, published in 1950 by the Department of Education, the opinion is given that "...we have weakened our high school system in recent years by endeavoring to force all into the severe academic pattern of university matriculation,"³² and concern was felt about the large numbers of young people who were leaving school prior to graduation. In reference to these reasons for revision, the Curriculum Guide stated:

Secondary education...like any other established agency of society, is conservative and tends to resist modification. Failure to make adjustments when the need arises leads to the necessity for extensive reorganization at irregular intervals. The evidence is strong that such a comprehensive reorganization is imperative at the present time.³³

General Purposes and Principles of Secondary Schools

The new curriculum guide outlined the three general purposes of secondary education in Alberta, which were the foundation of the new revision, as follows:

- a) the fullest realization of the youth's personal potentialities;
- b) the preservation and improvement of our democratic social order;
- c) the understanding, utilization and improvement of the physical environment.³⁴

The general principles to guide school organization, based on these purposes were: that the high school should be so organized that it was capable of meeting the needs of all educable youth, both matriculants and non-matriculants, until they reach the age of eighteen; and, that the organization should provide multi-track programs to accommodate the broad range of backgrounds, abilities, needs, preferences, previous experiences, interests and ambitions.³⁵

³²Province of Alberta, Department of Education, Curriculum Guide for Alberta Secondary Schools, 1950, p. 21.

³³Ibid., p. 20, citing Leonard, J. Paul, Developing the Secondary School Curriculum. (New York: Rinehart and Company, 1946).

³⁴Ibid., p. 7.

³⁵Province of Alberta, Department of Education, Curriculum Guide for Alberta Secondary Schools, 1950, p. 21.

These principles were reminiscent of those stated at the turn of the century by Dr. Goggin.³⁶

The purpose of the school, which was said to be "...not so much to teach pupils all the facts they have not yet mastered, as to hasten into action all the desirable behaviors they have not yet attained"³⁷, was to be the chief criterion in the selection of content. Therefore, content should be:

- 1) organized around problems of contemporary living;
- 2) organized on a 'broad fields' basis because the foregoing problems cut across the boundaries of traditional subjects;
- 3) selected to provide for continuity and articulation of learning experiences from grade VII to grade XII inclusive.³⁸

Proposed Revisions to the Physical Science Program

The purposes of secondary education as outlined in the preceding section were reflected in the reorganization of the physical science courses. In 1952, Chemistry 1 and Physics 1 were replaced in grades X and XI by two new courses, Science 10 and Science 20.

The responsibility of providing science education suitable for all high school students, whether or not they intended to pursue more advanced studies in science, was acknowledged and two specific purposes were set forth for Science 10 and Science 20 as follows:

- 1) To provide two years of science education suitable to all high school students.

³⁶Supra, pp. 38 - 39.

³⁷Province of Alberta, Department of Education, Curriculum Guide for Alberta Secondary Schools, 1950, p. 22.

³⁸Ibid.

2) To provide a satisfactory basis for the study of the grade XII science courses required for university matriculation.³⁹

Under the new courses the term 'physical sciences' was said to imply "...a reorganization of subject matter and concepts drawn from the whole science field, rather than the rejection of the contents of the more familiar specialized courses--chemistry, physics and geology."⁴⁰

The keynote of the change at this time is reflected in the following quotation from the introduction to the curriculum guide:

Science discoveries have accelerated and pyramided, and the speed with which we are acquiring new knowledge has set the tempo of our age. Each major discovery bears its accompanying social and economic problem; each major discovery has national and international implications...science education must develop habits, attitudes and understandings over and above the facts of science.⁴¹

The changes comprising this revision were based on the conception that science information is "...a major determinant of our way of thinking and acting."⁴² No longer was the addition of a few new topics, selection of a more modern textbook and a re-emphasis of the importance of laboratory work considered as a revision of the program. It was recognized that there were areas of specialization, within each of the sciences, to which an individual could devote a lifetime of study and research. To consider that the typical high school student, by studying two courses in chemistry and two in physics, could begin to acquire significant amounts of knowledge in terms of the sum total now

³⁹Province of Alberta, Department of Education, Curriculum Guide for Science 10 (Interim Edition), 1952, p. 6.

⁴⁰Ibid., p. 5.

⁴¹Ibid.

⁴²Ibid.

available to man in each discipline, was totally unrealistic. It was considered that the needs of the majority of high school pupils could be better served by a study of important principles drawn from a whole range of physical phenomena. The term 'physical science' was to be interpreted in the collective sense and studies were to be drawn from geology, meteorology, and astronomy and no longer restricted to a vertical approach within the narrow confines of chemistry and physics.⁴³ From 1952 on, this expanded concept of physical science necessitated new units of work in the high school beyond the limitations of this study.

The effect of this changing concept will only be judged in retrospect. The nature of the approach and the direction of the change are still unsettled and therefore, it is not yet possible to view this revision with proper perspective in the historical sense. This brings to its conclusion a period of almost sixty years in Alberta's high schools during which physics and chemistry comprised the major courses in physical science studies.

⁴³Hogg, John C., et al, Physical Science for Canadian High Schools. (Toronto: D. Van Nostrand Company, 1958), p. v.

CHAPTER XI

DISCUSSION AND CONCLUSIONS

The background and development of the Alberta secondary school physical science program have been presented and where possible, the reasons for and nature of revisions to the program were indicated.

In this chapter the major aspects in the evolution of the physical science program in Alberta will be subjected to critical analysis and the effect of certain significant factors and influences, underlying its development, discussed.

I. SECONDARY SCHOOL PHYSICAL SCIENCE:

ITS PURPOSES, STATUS, CONTENT, AND METHODS OF INSTRUCTION

Stated Objectives of High School Physical Science

In the early stages of development of physical science programs in Canada, two major objectives of science education were advanced: to develop the "intellect", and to acquire practical knowledge. Egerton Ryerson postulated the value of science education in both utilitarian and intellectual terms, while Inspector Young considered it to be important in the development of the habit of intelligent observation, and the learning of the inductive method of discovering truths.¹ Essentially, these are the same purposes for science education advocated today, a fact which attests to the vision and foresight of these early Canadian educators.

In later curriculum revisions, more comprehensive statements of objectives for science education were given,² with re-emphasis of the importance of teaching the processes of science by the laboratory method. Thus at no stage during the period studied has there been a lack of stated aims to

¹Supra, pp. 9 - 11.

²Province of Alberta, Department of Education, Senior High School Curriculum Guide for Science 10 (Interim Edition), 1952, p. 6.

guide programming and instruction in the secondary school physical sciences. However, it appears that very few of these objectives were realized to any significant degree in the classroom. Certainly, the learning of the processes of science has been neglected because of the limited use and restricted function of the laboratory. Factors impeding the achievement of these and other objectives of the various programs are discussed on pages 139 - 144.

The Status of Physical Science

It seems probable that the same forces which compelled other provinces and countries to include chemistry and physics in their curricula were responsible for the inclusion of these subjects in the first Alberta high school curriculum.

Although physical science courses have generally been elective subjects, except for students preparing to enter the teaching profession or to qualify for matriculation, they have comprised an important part of the Alberta secondary school program throughout its history. (See Table V, page 134.)

With the upsurge of science and technology at the beginning of the twentieth century, science began to be regarded as important for general education. At the same time the high school population began to expand rapidly and wider variations of student interests and abilities had to be met. In an attempt to solve this problem, General Science electives were added to the Alberta secondary school program in the 1937 revision but failed to achieve wide acceptance.³ Similarly, the broader physical science courses introduced in 1952 did not prove to be acceptable to a substantial segment of the high school population. By contrast, chemistry and physics have retained their dominant position in the high school program throughout the history of its development in Alberta.⁴

³Province of Alberta, Department of Education, Annual Report, 1941, p. 21.

⁴Supra, p. 134.

TABLE V

SUMMARY OF PHYSICAL SCIENCE COURSES
OFFERED IN ALBERTA HIGH SCHOOLS, 1889 - 1952

YEAR	STANDARD VI	STANDARD VII	STANDARD VIII	
1889-1890*	Chemistry Statics, Hydro- statics and Physics	---	---	
1891-1896	Chemistry Statics, Hydro- statics and Physics	Chemistry Statics, Hydro- statics and Physics	Information lacking	
1896-1902	Physics	Physics	Physics Chemistry	
1902-1906	Physics	Physics Chemistry	Physics Chemistry	
1906-1907	Physical Science	Chemistry	Physical Science	
1907-1912	Physical Science	Physical Science Chemistry	Physical Science Chemistry	
	GRADE IX	GRADE X	GRADE XI	GRADE XII
1912-1923	Elementary Science (Bot. Zoo., Physics)	Elementary Science (Bot. Zoo., Physics)	Chemistry Physics	Chemistry Physics
1923-1937	General Science	Physics 1	Chemistry 1	Chemistry 2 Physics 2
1937-1952**	---	Chemistry 1 General Science 1 Geology 1	Physics 1 General Science 2	Chemistry 2 Physics 2
1952 -	---	Science 10	Science 20	Chemistry 30 Physics 30

*There was no high school instruction beyond Standard VI in the first year.

**Subsequent to 1937, Grade IX became part of the Intermediate or Junior High School.

It can only be a matter of conjecture why the academic subjects, required only for matriculation, were held in high esteem by those who could not pursue their education beyond the high school level. Dr. H. C. Newland, Supervisor of Schools for the Province, commented on this preference in secondary education as follows:

...Many reasons have been advanced to explain this situation: inertia of tradition; the prestige or 'honorific value' as Veblen would say, of the orthodox canon of subjects; the selective value of the subjects; entrance requirements for the professional schools; the vested interests of subject minded teachers. All of these things have had their effect undoubtedly; but it may be questioned whether the economic urge is not a more potent factor than any of them. Until the outbreak of war ours was a scarcity economy in which all social services were undernourished and the traditional bookish type of education could be offered at no great cost for teaching service or equipment. Our resources are comparatively undeveloped, and occupations are therefore not greatly diversified. In the competition for 'white-collar' jobs parents naturally direct their children to that type of education that will admit them to the preferred vocations.⁵

Content Revision of Physical Science Courses

A tendency toward stability, rather than marked change, has been a keynote of the revisions to content in both chemistry and physics. Until the 1912 revision, chemistry consisted primarily of a descriptive study of the elements and their compounds. Authors of textbooks were slow to include explanations of chemical phenomena based on the atomic hypothesis, the theory of electrolytic dissociation, and the electron theory of valence. By 1923 these theoretical foundations were accepted as the bases for the explanations presented in the high school textbooks. Throughout the period studied, theoretical chemistry gradually assumed increasing importance in the program mostly at the expense of descriptive chemistry.

⁵Province of Alberta, Department of Education, Annual Report, 1941, p. 21.

However, until recently, organic chemistry has not been given the emphasis commensurate with its importance in medicine, industry, public health and agriculture.

In physics the situation was very similar, with the emphasis in early programs on the descriptive rather than the quantitative aspects of the subject. The textbooks retained outmoded explanations and lagged in their incorporation of new scientific developments. Examples of this would be the undue retention of the concept of the ether, and the slowness in basing explanations of electrical phenomena on the electron theory of matter.

It appears that most of the prescribed texts in chemistry and physics placed considerable emphasis on the technological applications of science, especially where these came within the realm of the students' experiences. This trend continued in the 1952 revision and only recently has been challenged by such new programs as the Chemical Bond Approach chemistry⁶ and the Physical Science Study Committee physics.⁷

It is difficult to assess the effect which educational philosophy and pedagogical theory have had on the nature and extent of curriculum revision. Stated objectives, for example, have seldom resulted in significant changes in course content. A major concern of Alberta curriculum writers has been the selection of more modern textbooks. As a result physical science curricula have been textbook-curricula which tend to be restrictive in content and provide little incentive for variations in methods of instruction. Attempts to meet the growing range of interests, abilities and needs through the introduction of General Science courses may also be criticized because it has not been demonstrated that they fulfill the requirements for general education any better than does content

⁶Chemical Bond Approach Project, Chemical Systems. (St. Louis: McGraw Hill Book Company, 1964).

⁷Physical Science Study Committee, Physics. (Boston: D. C. Heath and Company, 1960).

selected from physical science. Multi-track courses in physical science are feasible and have only recently appeared in the Alberta secondary school program.

It seems that throughout the various revisions of the high school curriculum, content selection has received only cursory consideration. Professor Young's viewpoint, that course content should be selected from a very limited number of topics, although not accepted by curriculum makers for almost one hundred years, corresponds to that adopted by the Physical Science Study Committee, which was seriously challenged to find a solution to the problem of content selection at a time when the explosion of knowledge, following World War II, made this such a compelling problem.

Method of Instruction: Theory and Practice

The reports of inspectors and superintendents, throughout the period studied, make frequent reference to shortcomings in the quality of instruction in physical science. The criticisms outweigh the favorable comments and appear to center around the insufficient use of demonstrations and laboratory experiences.⁸ A number of factors apparently contributed to this situation: inadequate facilities especially in the small high schools, poorly qualified and over-burdened teachers, overcrowded classrooms and schedules, Departmental Examinations and too much reliance on the textbook.

Teachers' understanding of the objectives of science education and how these might be realized in the classroom could also be questioned. Certainly the emphasis has been on rote memorization of facts while other purposes, such as teaching the processes of science in a laboratory environment, have often been neglected. The fundamental importance of laboratory work and experimentation have been acknowledged in all programs of study and course outlines. A list of

⁸Supra, pp. 80, 95, 97.

experiments was usually prescribed or included in the authorized textbook. Most often the purpose of these experiments was not to discover, but rather to verify or illustrate, certain principles and laws of science which had previously been presented to the student.

In addition, there was no dearth of ideas on how science should be taught. Professor Young and others strongly advocated inductive teaching and learning of science through discovery. Gage's position, that proper science instruction involved judicious use of oral instruction, the textbook, the laboratory and the inductive approach, was generally accepted.⁹ The nature of this "balance" has yet to be determined and a solution to the dichotomy between theory and practice in science instruction has yet to be found.

The generally deleterious effects of Departmental Examinations on instruction has been noted by many Alberta educators. The consensus of their opinions regarding these was expressed in 1934 by Dr. H. C. Newland who reported an undesirable type of instruction prevalent in the schools which encouraged students to memorize factual material for reproduction on the final examination. Examination questions were based on material from the textbook and did not require scientific deductions or the understanding of basic principles.

The physical science courses were generally subjected to Departmental Examinations each year, until 1937, at which time the testing policy of the Department was changed, and examinations were administered in grades IX and XII only. Following the revision of the grade XII program in 1939, a new type of examination was set, using a variety of testing techniques such as multiple choice questions, short answer completion, et cetera. It attempted to test for such factors as reasoning, understanding, drawing conclusions from stated

⁹Supra, p. 48.

facts, application of principles to new situations, and "...all-round growth and development".¹⁰ Although considerable progress has been made in devising tests for the above-mentioned factors, the problem is far from settled.

II. FACTORS INFLUENCING THE DEVELOPMENT OF THE PHYSICAL SCIENCE PROGRAM

The Purpose of Secondary Education

The first statement concerning the reason for establishing high schools in Alberta was to the effect that the primary purpose of such schools should be to provide a higher level of general education rather than the training of young people as teachers.¹¹ In 1902, Dr. D. J. Goggin expressed the view that since the majority of students did not go to college and should not seek to become teachers, it was the needs of these pupils in becoming better citizens, and not the entrance requirements of institutions of higher learning, which should determine the high school course of studies.¹² For these reasons courses in physical science were frequently among the subjects which were classed as optional, except for those wishing to enter college or become teachers.

In the period from 1912 and continuing after World War I, it was generally recognized that the program had two responsibilities to students: to provide the majority with a higher level of general education, and to provide for the needs of the minority preparing for university. As a consequence, the academic physical science electives were included as part of the regular high school program, but they were considered optional electives except for those students seeking matriculation.

¹⁰Supra, p. 115.

¹¹Supra, p. 18.

¹²Supra, p. 39.

A specific reason for inclusion of science in the secondary school program emerged after World War II, when the "explosion of knowledge" in science and the resulting technological revolution made an understanding of the principles of science necessary for effective citizenship, as science information was considered "...a major determinant"¹³ in the way that people think and act. Since scientific principles could be drawn from the whole field of science, the former introductory courses in Chemistry 1 and Physics 1 were replaced by Physical Science 10 and 20 which drew their content from all branches of the physical sciences. However, because of the needs of students seeking matriculation, the grade XII courses in physical science continued to be restricted to chemistry and physics.

It seems to have been accepted early in the history of education in Alberta that the high schools must be primarily concerned with the general education of all students. It is beyond the scope of this study to assess the success of the total secondary school program in achieving this aim. However, there appears to have been some misunderstanding about the place of physical science in general education. It has been, and still is, possible to complete a high school program in Alberta without taking a course in physical science, a situation which seems inconsistent with the stated purpose that an understanding of science principles is necessary for effective citizenship. The concern about the "explosion of knowledge" in science and "mushrooming" technology has had its impact on the programming of content, but limited or no impact on the requirements for a completed secondary education.

Economic Conditions and School Organization

Until the end of World War II, Alberta's was a scarcity economy, typically lacking in diverse industrial development.¹⁴

¹³Supra, p. 130.

¹⁴Supra, p. 135.

Revenue sources for the provision of public services, such as education, were very limited. During periods of economic depression the situation became more serious. Furthermore, the economic strain on the school system was increased by the rapidly expanding student population. This too became more serious during depressions, since that portion of the student population which normally tended to leave school near the legal age limit and be absorbed into the labor force continued their education because opportunities for employment were lacking.

The more diverse requirements of this enlarged school population created a pressing need for varied programs. The earlier attempts at a multi-track program had limited success since, primarily for economic reasons, few school districts in the province were able to offer the technical or commercial courses. It appears that only the economic recovery of the last war and post-war period along with the centralization of schools has made possible the success of multi-track programs.

Unfavorable economic conditions during periods of depression had an especially adverse effect on the quality of physical science instruction. During these periods classrooms and laboratory facilities were generally over-crowded and the necessary equipment and supplies either inadequate or barely minimal, as is made abundantly clear in the reports of high school inspectors.¹⁵

The reorganization of Alberta school districts into larger administrative units known as Divisions, had a considerable influence on the quality of secondary education, especially in rural areas. Under frontier conditions, settlement was sparse in many regions of the province and as a result, much of Alberta was organized into small school districts which had only a one-room school, centrally located. These small districts lacked the resources to provide the

¹⁵Supra, p. 80.

facilities, equipment and qualified teachers for the teaching of the high school physical science.

Following the organization of larger administrative units and the centralization of many rural high schools, the inspectors reported generally improved facilities and equipment. The benefits to be derived from these were, however, frequently offset by the rapid expansion of the student population which seemed, consistently, to have exceeded the rate at which adequate facilities and equipment were provided. Despite the ability of large high schools to make more courses accessible to students than is possible in small high schools, rigidity in timetabling, very high enrolments, and high pupil-teacher ratios in science classes, have frequently placed serious limitations on the science program. This has been the case especially with respect to the adequacy of laboratory facilities for individual student experimentation. Thus, the full potential of centralization was not realized in the teaching of physical science.

Governments, at both the provincial and local levels, must share the responsibility for the frequent lack of physical conditions that would have helped make possible excellence in the teaching of physical science. Moreover, officials of the Department of Education, school administrators and teachers may be criticized for their failure to provide the necessary leadership in this regard.

Effect of Dominant Personalities and Textbook Authors

Several times throughout the period covered in this work, the influence of an individual educator with definite views and necessary position of authority to have his recommendations tried and tested, has had its effect on the curriculum. Notable among these personalities were Dr. Goggin and Dr. Tory.

Dr. D. J. Goggin, whose convictions as to the importance of nature study in the elementary grades led to an increased interest in science work in the high schools, and whose views

on the purposes of secondary education laid the foundation for the 1902 revision, was the first to introduce to Alberta the elective principle of selecting courses. In 1898, he rewrote the physics program and in 1902, added a second course in chemistry to the list of high school subjects.

Dr. H. M. Tory organized and served as first President of the University of Alberta. When the Provincial Government instigated the first revision of its public school system, Dr. Tory was appointed chairman of the revisions committee. His viewpoint, that the university should be the coping stone for the entire educational system was reflected in the 1912 revision which resulted in the inclusion of four courses in physics and two in chemistry in the high school program.¹⁶

The indirect influence of educators from other provinces and countries has been a significant factor in the development of secondary education in Alberta. Early curricula were based on Ontario's educational system which had been designed by Egerton Ryerson. Authors of science textbooks from Ontario, the United States and Great Britain, who had their books authorized for Alberta schools had a two-fold impact on secondary science education through their ideas on content selection and organization, and their suggestions regarding instruction. Their influence would have been more pronounced if there had been more significant changes in the content of their texts and if teachers had been more receptive to the suggestions regarding methods of instruction and new approaches to science education.

The Inertia of Tradition

Inertia has plagued the process of revision in the Alberta high school physical science curriculum. Records for this province reveal little original work in the development of new programs, textbooks and teaching practices. Instead,

¹⁶ See Appendix C, pages 194 - 195.

the tendency has been to wait for change elsewhere, especially in Ontario and the United States and then to adopt these revisions with only slight modification. Other evidence of inertia has been the long intervals of time which have elapsed between major curriculum revisions and also, between new textbook authorizations.

Reasons for this inertia are obscure, but lack of leadership at all levels of the province's educational system has contributed to the situation. The teacher has been at fault for a tendency to want to teach familiar subject matter, using traditional methods.

Finally, parents must accept some responsibility for their tendency to adopt a rather conservative outlook regarding reorganization of schools, new curricula and methods of instruction.

III. MAJOR CONCLUSIONS

An analysis of the evolution of the physical science program in the Alberta secondary school system indicates that:

1) Physical science has retained a firmly established position as an important and integral part of the secondary high school program in Alberta.

2) Secondary school science programming and instruction have been consistently guided by reasonable objectives, but many of these were not realized to a significant degree in the classroom.

3) With respect to content, the physical science curriculum has been noteworthy for its tendency toward stability rather than for sweeping changes. Generally, the revisions seem to have been more concerned with changes in emphasis than with major alterations in content.

The most striking consistency of all, and an emphasis which has prevailed despite all curriculum changes, has been the preoccupation with content and the somewhat limited concern for the processes of science.

4) The Departmental Examinations, although serving as a means to control standards of teaching and learning, and to set levels of achievement, have often led to over-emphasis in the learning process on drill and rote memorization of facts from textbooks. This has placed limitations on the realization of many of the other worthy objectives of science education.

5) The quality of instruction in physical science in many secondary schools has been limited by a number of factors, such as inadequate equipment and facilities, poorly qualified and over-burdened teachers, and insufficient use of good methodology in the teaching of science.

6) Of the factors which have affected the Alberta physical science program those impeding its development have, for the most part, exerted greater influence than those factors promoting the introduction of new approaches in science education. The general result has been a dearth of enthusiasm for new programming, a persistent tendency to maintain the status quo and therefore, a hiatus between the forefront of science knowledge and the content of courses in high school physical science.

IV. RECOMMENDED STUDIES

1) A more encompassing study of the development of the Alberta science program, which would include science in all of the grades, and devote special attention to continuity and the interrelationships among the sciences.

2) A more rigorous study of the effect of some of the influencing factors mentioned in this study (for example, the effect of the University and of the Departmental Examinations on programming).

3) A more rigorous comparison of the content of the physical science program at particular periods with the major new ideas prevalent in the science, and determination of the reasons for the lag.

4) A study of the reasons and factors which interfere with maximum realization of the objectives for science instruction.

5) A study of the organization and function of curriculum revision committees, with attention given to their composition, responsibilities and authority, and the relationship of these to the physical science programs produced.

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APPENDIX A

EXAMINATION PAPERS - CHEMISTRY

Botany and Chemistry, Class I, February, 1888

Chemistry and Botany, Class I, August, 1888

Chemistry and Botany, First Class, 1890

Chemistry and Botany, First Class - All Candidates, June, 1891

Teachers' Examinations, 1897, Chemistry - First Class, Standard
VIII

Chemistry Examination, 1900

Standard VII, Chemistry, 1903

Grade XII Chemistry From 1913 Annual Report, Dated June 25,
1914

Departmental Examinations, 1926 - Chemistry 2

BOTANY AND CHEMISTRY*

Time: 2 hours

CLASS I

FEBRUARY, 1888

Examiners - Rev. A. B. Baird, M. A., B. D.
Rev. D. Granton, B.A.

BOTANY

5 questions.....(excluded here)

CHEMISTRY

1. When a candle burns, is there any loss of material?
Explain your answer.
2. In what state does water exist? and what temperature
does it require for the different states?
3. What is the composition of water?
4. What is the chemical composition of air, and how is
this composition affected -
 - (a) by animal life
 - (b) by vegetable life
 - (c) by combustion
5. Of how many parts does the flame of a candle consist
and in what state is the gas in each part?

*Taken from the Report of the Board of Education of
the North West Territories, 1888.

CHEMISTRY AND BOTANY*

Time: 2 hours

CLASS I

AUGUST, 1888

Examiners..Rev. D. Graton, B. A.
Thos. Grover, B. A.

CHEMISTRY

1. What is meant by (a) chemical action (b) metals and non-metals?
2. Name the metals which are lighter than water.
3. Say what you know about hydrogen.
4. What is the composition of coal gas and how is it produced? for illuminating purposes?
5. What is fermentation and what are the principal forms of fermentation?

BOTANY

6. (Questions on botany constitute the second part of the paper.)

*Taken from the Report of the Board of Education of the North West Territories, 1888.

CHEMISTRY AND BOTANY *

Time: 2 hours

FIRST CLASS

1890

Examiners... Rev. D. Graton, B. A.
Geo. W. Brown

CHEMISTRY

1. Name ten of the commonest elements.
2. What alteration in volume do gases undergo when exposed (a) to heat (b) to pressure?
3. Describe the most exact methods of obtaining the composition of water (a) by volume (b) by weight.
4. How is the composition of air affected by (a) animal life (b) vegetable life (c) combustion?
5. Give the formulae representing two different modes by which ammonia can be produced.
6. What is the composition of marsh-gas and fire-damp?
7. Name the tests by which arsenic can be detected with certainty.
8. How does starch differ in constitution from glucose?

BOTANY

(5 questions)

*Taken from the Report of the Board of Education of the North West Territories, 1890.

CHEMISTRY AND BOTANY*

FIRST CLASS - ALL CANDIDATES

June, 1891

Time: 2 hours

Examiners...Rev. John McLean, M. A.

Rev. H. Leduc, B. A.

CHEMISTRY

1. What are the chemical properties of air? Explain your method of proof.
2. Describe the experiments proving the analysis and synthesis of water.
3. Upon what does combustion depend? How may the luminosity of a flame be increased? Upon what does the ignition point of a substance depend?
4. When nitric acid HNO_3 is boiled, what is the result? What are its uses? In what form does it exist in nature?
5. Insert a piece of moistened calico into dry chloride, what will be the result? Explain the bleachine power of chlorine. What is a disinfectant?

BOTANY

(5 questions)

*Taken from the Report of the Board of Education of the North West Territories, 1890.

CHEMISTRY - FIRST CLASS*

Time: Two Hours

Standard VIII

1. (a) Show by means of a simple experiment that when two or more substances are brought together under certain conditions an entirely new compound may be formed. Briefly outline the theory which offers an explanation of this phenomenon.
(b) Give illustrations to show that heat, light and electricity may be an effect as well as a cause of chemical action.
2. Describe minutely the laboratory preparation of small quantities of any two of the following:
Marsh-gas, sodium hydrate, nitric acid.
3. Explain the chemical reaction that occurs in the different methods adopted to render hard water soft.
4. (a) Compare the chemical and physical properties of Hydrogen and nascent Hydrogen, Oxygen and Ozone, Charcoal and Graphite.
(b) Show experimentally the use that may be made of charcoal as an absorbing, deodorizing and reducing agent.
5. Describe, giving equations, what will occur in each of the following experiments:
(a) A current of Hydrogen gas is passed through a tube containing heated Copper Oxide.
(b) A current of Carbon dioxide is passed through a solution of Calcium hydrate.
(c) A current of Sulphuretted hydrogen is passed through a solution of Copper Sulphate.
6. A test tube is known to contain one of the following substances in solution, Caustic Potash, Potassium Iodide, Arsenic or Hydrochloric Acid. How would you determine which of these is present?
7. "Chemical properties which force themselves upon our attention most prominently in whatever field of chemistry we may be working are those which are known as acid properties and basic properties." Explain this statement.
8. A jet of Hydrogen is ignited in a jar containing the Oxygen obtained from the complete decomposition of 20 grams of Potassium Chlorate. When all the oxygen is used up the jet is removed.
(a) Find the weight of the resultant compound.
(b) What weight of zinc was used to produce the Hydrogen that was burned?
(K = 39.1; Zn = 65; Cl = 35.5; O = 16; H = 1; S = 32)

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1897.

CHEMISTRY EXAMINATION *

1900

Time: Two Hours

1. (a) State Avogadro's Law and describe and explain at least two simple experiments that verify it.
(b) "This law is considered the most important in the whole range of chemical science." Show its importance.
2. (a) Explain the difference between the atomic and molecular weights of an element.
(b) How may the former be ascertained?
3. (a) Explain the action of MnO_2 in the production of oxygen from KClO_3 .
(b) Classify oxides and state the characteristic properties of each class.
4. Give equations to illustrate the chemical reaction that takes place in each of the following experiments and name the resulting products:
(a) Add a little granulated zinc and iron filings to a strong solution of caustic potash.
(b) Fill a dry bottle with carbon dioxide and place it mouth down-wards over a bottle of ammonia.
(c) Heat a small piece of potassium in a deflagrating spoon and plunge it into a bottle of dry hydrochloric acid gas.
5. (a) Outline the method of obtaining phosphorus from bone ash. Represent by equations all the reactions that take place.
(b) Enumerate the distinguishing properties of red and yellow phosphorus and explain how the former may be obtained from the latter.
6. Describe the laboratory preparation of hydrochloric acid. State the properties and uses of this acid.
7. (a) Describe Reinch's test for arsenic.
(b) Name an antidote to arsenic poisoning and explain its action.
8. Explain any method by means of which hard water may be rendered soft.
9. (a) Enumerate the different modes of chemical action.
(b) Which of the modes is followed in the chemical actions that take place in the experiments mentioned in questions 3(a), 4(a), 5(b)?

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1900.

STANDARD VII

1903

CHEMISTRY

Time: 2½ hours

1. (a) Describe 3 ways in which hydrogen may be prepared. Write the equations in each case.
(b) What is the weight of oxygen in 100 lbs. of pure water?
2. (a) What is the atomic theory?
(b) How does it explain the laws of chemical combination?
3. (a) State the properties of nitric acid. Give experiments illustrating these properties.
(b) By what means would you test for free nitric acid?
(c) State the facts represented by the formula HNO_3 .
(d) How many pounds of nitric acid can be obtained by distilling 400 pounds of sodium nitrate with sulphuric acid?
4. (a) Describe the chemical changes which take place in the flame of a tallow candle.
(b) How may the flame of an ordinary gas jet be made non-luminous?
5. Outline the preparation of carbon dioxide and state its properties. How would you distinguish it from (a) nitrogen, (b) carbon monoxide?
6. (a) Sketch the manner in which iron is obtained from its ore.
(b) You are given a sample of water. Show how you would test for iron.
7. Sulphur is burned and the products of combustion are passed into water. To the resulting solution iodine is added. Write equations representing the chemical changes which take place.
8. What are the various impurities that exist in natural waters? Describe modes by which their presence in a particular sample may be determined and how water containing them may be made pure.
What reactions take place in hard water when it is made soft?
9. (a) State the chemical relations which exist between chlorine, bromine and iodine.
(b) Show the similarity in the methods of obtaining each.
(c) Describe an experiment to show that chlorine has a stronger affinity for a metal than bromine has.

STANDARD VII CHEMISTRY (continued)

10. (a) Distinguish between combustible substances and substances that support combustion.
- (b) Illustrate by equations the chemical reactions which occur in the combustion of:
 - i. Hydrogen in chlorine
 - ii. Hydrogen sulphide in oxygen
 - iii. Sodium in hydrochloric acid gas.
11. Solutions of sulphuretted hydrogen, ammonia, nitrous acid, and arsenic are each contained in separate bottles. Describe the tests used in each case to determine the substance in each solution.

GRADE XII CHEMISTRY

FROM 1913 ANNUAL REPORT, DATED JUNE 25, 1914*

Time: 2½ hours

Examiner - J. A. Fife, B.A.,
M. Sc.Note: 125 marks is a full paper. Candidates may select
either Question 10 or 11.

VALUES

- 5 1. (a) Describe an experiment to show the proportions by weight in which magnesium and oxygen combine.
- 5 (b) Prove by experiment that two volumes of hydrogen combine with one volume of oxygen.
- 2+6 2. (a) State the law of multiple proportion and illustrate by reference to the compounds which oxygen forms with (i) nitrogen, (ii) carbon, (iii) hydrogen.
- 5 (b) Accurately describe the experiment on which the following quantitative reaction is based:
- $$\text{KClO}_3 = \text{KCl} + 3\text{O}$$
3. Write equations to express the chemical reactions which take place in each of the following experiments:
- 3 (a) Sulphuric acid is warmed with a mixture of common salt and manganese dioxide.
- 3 (b) A tall cylindrical glass jar is filled with a saturated solution of chlorine in water and placed mouth downwards in a vessel containing some of the same solution; the vessels thus arranged are placed for about 24 hours in bright sunlight.
- 3 (c) A solution of bromine in water is added to a solution of sodium iodide.
- 3 (d) Chlorine gas is passed into a cold solution of caustic soda to saturation.
- 3 (e) Chlorine gas is passed to saturation into a strong hot solution of caustic potash.
- 12 4. Compare the nitrogen group of elements by reference particularly to their compounds with (i) hydrogen, (ii) oxygen.
- 7 5. (a) Explain the general method of extraction iron from its ores, giving equations expressing the different reactions.

*This was based on Remsen, I., Chemistry, Briefer Course.
(New York: Henry Holt and Company, 1909).

GRADE XII CHEMISTRY (CONTINUED)

VALUES

- 4 5. (b) Describe a laboratory method for preparing and collecting hydrogen sulphide.
- 6 (c) Discuss the importance of sulphuretted hydrogen in qualitative analysis.
- 2+2+2 6. Give experiments which will enable you to detect:
2+2 (a) Nitrates, (b) Chlorates, (c) Sulphites, (d) Silicates, (e) Sulphates.
- 6 7. (a) Write the equations showing the reactions which take place when an artificial fertilizer is made from bone ash, phosphorite or guano.
- 3 (b) Show how you would distinguish between calcium, strontium and barium by the flame test.
- 7 8. (a) Describe experiments showing how you would reduce nitric acid to ammonia.
- 4 (b) Write equations expressing the reactions which take place in the experiments in (a).
9. Describe the physical changes, and write equations to express the chemical changes which take place in each of the following cases:
- 4 (a) A piece of silver is placed in dilute nitric acid and slightly warmed.
- 4 (b) A piece of chemically pure zinc is placed in part of the substance resulting from (a).
- 5 (c) Dilute hydrochloric acid is added to a second portion of the substance formed in (a) and the precipitate after filtration is washed and exposed to light for some time.
- 3 10. (a) State Dulong and Petit's law.
- 4 (b) The specific heat of a certain metal is .0952. Find its atomic weight.
- 8 (c) Show clearly how the boiling point and freezing point of a substance may be used to find its molecular weight.
- OR
- 5 11. Write concise notes on each of the following:
- (a) The metallurgy of aluminium and the uses to which the metal is put.
- 5 (b) The manufacture of steel.
- 5 (c) The production of nickel from its ores, and its uses.

DEPARTMENTAL EXAMINATIONS, 1926--CHEMISTRY 2*

Time: Three hours

VALUES

- 1 1. (a) State the commercial source of which helium is obtained.
- 1 (b) What property of helium makes it possible to separate it from the other gases with which it occurs?
- 4 (c) State two commercial uses of helium and give the property of the gas which makes it valuable in each case.
- 3 2. (a) Describe the preparation of metallic calcium.
- 1 (b) What two chemical compounds makes up air-slaked lime?
- 2 (c) Write an equation to show the liberation of chlorine from bleaching powder.
- (d) Write equations to express the reactions which take place in the following:
- 2 (1) The making of calcium carbide.
- 2 (2) The manufacture of calcium cyanimide.
- 2 (3) The use of limestone in making sodium carbonate.
- 4 3. (a) Write the equations which express the chemical changes which take place in the metallurgy of (1) tin, (2) lead.
- 6 (b) Write the equations expressing the chemical changes which take place in the making of the following compounds: stannic chloride, lead acetate and lead chromate.
- 1 4. (a) Name the elements which belong to the nitrogen family according to the periodic law.
- 6 (b) Give three reasons for placing the elements referred to in (a) in the same family.
- 2 5. (a) Write the equation which expresses the chemical changes which take place in obtaining phosphorus from its ore.
- 2 (b) Describe the preparation of super-phosphate fertilizer.
- 2 (c) Write the equation representing the chemical change which takes place in (b).
- 2 6. (a) State the source and name the mineral from which a large part of the world's supply of nickel is obtained.

*Province of Alberta, High School and University Matriculation Examinations Board.

DEPARTMENTAL EXAMINATIONS, 1926--CHEMISTRY 2 (Continued)

VALUES

- 4 6. (b) For what reasons, respectively, is nickel used in the following cases: coinage, domestic utensils, nickel steel, invar?
- 2 (c) Write the equation showing the reaction which takes place in the formation of ferric chloride.
- 3 (d) How would you, by experiment, distinguish between ferrous and ferric chlorides?
- 1 7. (a) State Avogadro's hypothesis.
- 2 (b) What facts pertaining to all gases are explained by this hypothesis?
- 3 (c) Accepting Avogadro's hypothesis, show that the molecule of chlorine consists of at least two atoms.
- 6 (d) The molecular weight of dextrose is 180. What change would be made in the boiling point by adding 450 grams of dextrose to 500 c.c. of water?
8. Write equations for the chemical reactions involved in the following experiments:
- 2 (a) Potassium permanganate is acted on by hydrochloric acid.
- 2 (b) Sodium peroxide is mixed with hydrochloric acid.
- 4 (c) Chlorine is passed into a water solution of sodium sulphite and barium chloride added to the resulting substance.
- 2 (d) Tin is acted on by strong nitric acid.
- 2 (e) Sulphuric acid is added to aluminum hydroxide.
- 4 9. (a) Briefly describe the industrial preparation of ethyl alcohol, explaining the chemical changes that occur.
- 2 (b) Write the equation representing the reaction when methyl alcohol vapor and air are passed over heated copper wire.
- 4 (c) Describe the preparation of nitro-glycerine and write the equation for the chemical reaction involved.
- 3 (d) What substance is formed when ethyl alcohol is heated with sulphuric acid and of what use is it?
- 2 (e) Write the equation for the chemical action which takes place in (d).
- 6 10. (a) You are provided with a dilute solution of lead nitrate and all necessary reagents. Fully describe the methods used to detect the base and the acid in the solution.
- 3 (b) Write a note on the use of hydrogen sulphide as an agent for grouping metals in qualitative analysis.

APPENDIX B

EXAMINATION PAPERS - PHYSICS

Statics, Hydrostatics and Physics, Class I, February, 1888
Statics, Hydrostatics and Physics, Examination of Teachers,
August, 1888
Statics, Hydrostatics and Physics, First Class, 1890
Statics, Hydrostatics and Physics, First Class - All Candi-
dates, June, 1891
Teachers' Examinations, 1896, Physics - Second Class
Physics - Third Class, 1896
Teachers' Examinations, 1897, Physics - First Class
Physics - First Class, 1900
Physics - Second Class, 1900
Teachers' Examinations - Non-Professional, Physics - Third
Class, 1900
Standard VI, Physics, 1903
Standard VIII, Physics, 1903
Departmental Examinations, Physics 2, 1926

STATICS, HYDROSTATICS AND PHYSICS

Time: 2½ hours

CLASS I

FEBRUARY, 1888

Examiners... Rev. A. B. Baird, M.A., B.D.
Rev. D. Gratton, B. A.

STATICS

1. Describe the wheel and axle, stating the relation between the power and the weight necessary in order to equilibrium.
2. Describe the screw, stating the relation between the power and the weight.
3. A weight of 80 lbs. is sustained in an inclined plane by a power of 60 lbs. acting parallel to the base; how many feet does the plane rise in the hundred?
4. Describe the two kinds of lever.
5. A piece of uniform wire is bent into the form of a triangle; find the position of the centre of gravity.

HYDROSTATICS

1. If the pressure of a fluid at a depth of 42 ft. be 15 lbs. to the square inch, what will be the pressure at a depth of 42 ft. 8 inches?
2. An iron spoon is gilded, and the mean specific gravity of the gilded spoon is 8, those of iron and gold are 7.8 and 19.4; find the ratio of the volumes and weight of metals employed.
3. How to graduate the Fahrenheit and Centigrade Thermometers.

PHYSICS

1. What is the velocity of light?
2. What is the theory of the propagation of sound?

STATICS, HYDROSTATICS AND PHYSICS
EXAMINATION OF TEACHERS
BOARD OF EDUCATION, NORTH-WEST TERRITORIES
(for all Candidates)

Time: 2 hours

August, 1888

Examiners.... Rev. D. Gratton, B.A.
Thos. Grover, B.A.

STATICS

1. Define statics.
2. Define (a) force, (b) equilibrium, (c) weight.
3. Name the qualities of a good balance with short explanation.
4. How would you determine the true weight of a body by a false balance?
5. Describe the common screw and explain its principle.
6. How is the efficiency of a screw affected by increasing
 - (a) the length of the arm
 - (b) the diameter of the screw
 - (c) the distance between the threads?

HYDROSTATICS

1.
 - (a) What is a fluid?
 - (b) Give difference between a fluid and a powder.
 - (c) What do you mean by LIQUID and GASEOUS fluids and by density of fluids.
2. What is the pressure of the atmosphere on bodies, and how is it we feel no inconvenience from it?
3. How is it that a barometer is a means of ascertaining approximately the height of a mountain?
4. Describe the SIPHON and explain its principle.

PHYSICS

1. Explain flotation in water.
2. How do you explain the action of blotting paper on liquids?
3. What is the difference between a noise and a sound?
4. What is an echo?
5. Name the good and bad heat conductors which are in use in common households.
6. What is the influence of points on electricity?

STATICS, HYDROSTATICS AND PHYSICS

FIRST CLASS

1890

Time: 2 hours

Examiners.....Rev. D. Gratton, B.A.

Geo. W. Brown

1. Define (a) a rigid body (b) equilibrium (c) magnitude of a force (d) gravity (e) weight.
2. Three posts are placed in the ground so as to form an equilateral triangle, and an elastic string is stretched around them, the tension of which is 6 lbs. Find the pressure on each post.
3. The resultant of two parallel forces acting in contrary directions is 12 lbs. and acts at a distance of 5 in. from the lesser force; find the forces.
4. How do you determine the true weight of a body by a false balance?
5. What is the principle of Virtual Velocities?

HYDROSTATICS

1. How would you find the resultant pressure of a fluid on a body wholly immersed and floating in a liquid?
2. What is the Hydrostatic balance?
3. Describe the forcing pump.
4. Water is 770 times as heavy as air, at what depth in a lake would a bubble of air be compressed to the density of water, supposing Mariotte's law to hold good throughout for compression.

PHYSICS

1. What are the chief forces of nature?
2. Give the properties of liquids.
3. Give the theory of sound.
4. What do you understand by reflection of light? and by refraction of light?
5. What is the nature of heat?

STATICS, HYDROSTATICS AND PHYSICS

FIRST CLASS - ALL CANDIDATES

June, 1891

Time: 2 hours

Examiners... Rev. D. Gillies, B.A.
Geo. W. Brown

STATICS

1. Explain the application of the principle of the Triangle of Forces to find the tension of strings.
2. How do you find the ratio of the power to the weight in the third system of pulleys?
3. Find the distance between the threads of a screw which is worked by an arm 20 inches long, when the power applied to its extremity is an 80th part of the pressure on the screw.

HYDROSTATICS

1. Explain the two-fold use of Nicholson's Hydrometer.
2. When the hundred graded thermometer shows 25° what will be the reading on the Reaumur and Fahrenheit thermometer?
3. If a substance weighs 8 lbs. in air and 6 lbs. in water, what is its specific gravity?

PHYSICS

1. Explain the principles of the telephone.
2. Define: Molecule, Atom, Atomic Weight, Molecular Weight, Force, Energy.
3. Describe briefly the process of spectrum analysis.

TEACHERS' EXAMINATIONS, 1896

PHYSICS - SECOND CLASS*

Time: 2½ hours

1. (a) State the height to which water may be raised by a syphon.
(b) If the areas of the cross-sections of the arms of a syphon are as 2:1 instead of as 1:1, how would its action be affected? Explain.
(c) Show clearly upon what the rapidity of flow in a syphon depends. Does altitude above sea-level affect it? Why?
(d) State and account for the limit of action of a syphon whose arms are of equal length.
2. (a) The spout of a lifting pump used to raise sulphuric acid from a tank, is 12 feet from the surface of the liquid, which is 14 feet deep. If the barometer stands at 28 inches and the Sp. G. of sulphuric acid and mercury is 1.8 and 13.6 respectively, find how many feet of acid may be pumped out.
(b) If the top of the tank which is partially filled, were sealed air-tight, how would the action of the pump be affected?
(c) What alterations are necessary in the construction of the pump in order to obtain a continuous flow?
3. (a) Find the height of a cliff if a stone dropped from its top reaches its base in four seconds.
(b) If at the end of the third second the stone is acted upon by a force that tends to carry it in a horizontal direction away from the cliff at a rate of 48 feet per second, show by means of lines how you would determine the velocity and direction of the stone at the end of the next second?
4. "One body is hotter than another when the average kinetic energy of each molecule in it is greater than in the other."
"Molecular potential energy is transformed in the act of chemical combination into heat."
Explain these statements.
5. Two pipes, A and B, connect an air-tight iron tank placed in the basement of a factory, with an open one placed on the second floor. Pipe A opens near the bottom of the lower tank while pipe B opens near its top. In the upper tank both pipes open a short distance

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1896.

5. (continued)
below the surface of the water, which completely fills the lower tank, the pipes and half the upper tank. If heat is applied to the bottom of the lower tank, describe and account for the manner in which the water will circulate. Indicate the position of the pipes that will secure the most complete and rapid circulation. Give reasons (In your explanation make use of diagrams showing the position of tanks and pipes).
6. (a) Why is a hollow box placed under the strings of a violin?
(b) Distinguish pitch, intensity and quality of sounds. Illustrate by reference to the key-board of a piano.
(c) Why is the sound made by the voice heard more distinctly at the end of a speaking tube than in the open air?
7. Describe the construction of a radiometer and state the inferences that may be drawn from its movements when exposed to the sunlight.
8. Show how the illuminating power of an incandescent lamp may be measured.
9. Show how the direction and relative strength of electric currents may be ascertained.
10. (a) Describe the construction of a voltaic cell and examine the physical and chemical conditions accompanying the generation of the current.
(b) Enumerate some of the practical uses made of voltaic cells.

PHYSICS - THIRD CLASS *

Time: 2½ hours

1896

1. (a) What common properties have all kinds of matter?
(b) Under what conditions will two trains be in a state of (i) relative motion, (ii) relative rest?
2. (a) Draw a diagram of an air pump and explain its action.
(b) Why is it impossible to obtain a complete vacuum by means of an air pump?
(c) Does the completeness of the vacuum depend in any way upon the capacity of the barrel of the pump? Explain.
(d) If the direction in which the valves open were reversed show what would take place when the pump is worked.
3. Explain -
(a) Why a balloon rises in the air, while iron sinks in water.
(b) Why the velocity of a falling body is independent of its mass.
(c) Why bullets are made of lead instead of wood.
(d) Why the course of a cannon ball projected in a horizontal direction is not straight.
4. "A syphon is an instrument used for transferring a liquid from one vessel to another through the agency of atmospheric pressure."
(a) Explain the statement making use of a diagram.
(b) Will a syphon work in a vacuum? Why?
5. (a) Describe the construction of a mercurial barometer.
(b) Why must one of the ends of the tube used be closed?
(c) If there is some air in the tube above the mercury how will it affect the reading of the barometer?
(d) Will the barometer rise or fall when taken down into a mine? Why?
6. (a) The utmost force a man can exert is a little more than 200 lbs. If he wishes to raise a block of stone weighing 400 lbs. show how he may do so by using (i) a fixed and moveable pulley combined (ii) a lever.
(b) Explain the meaning of the terms force, energy, and work by referring to what takes place while the stone is being raised by either contrivance.

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1896.

7. (a) Show how to find the specific gravity of a solid body heavier than water.
(b) Find the specific gravity of a goblet composed of 15 ounces of silver and 4 ounces of gold. (Sp. G. of gold = 19.36, Sp. G. of silver = 10.5).
8. State the three laws of motion and describe simple experiments in verification of any two of them.
9. An open U-shaped tube connects two bottles A and B in such a way that the ends of its arms are but a short distance from the bottom of each. Bottle A is half full of water and is so corked that air can enter only through the end of the tube in B. The mouth of bottle B is open. If the bottles are placed under the receiver of an air-pump, explain, making use of a figure showing the apparatus, the action that takes place -
 - (a) When the air is being exhausted.
 - (b) When it is being admitted.
 - (c) When the connecting tubes break in the centre during the second experiment.

TEACHERS' EXAMINATIONS, 1897

PHYSICS - FIRST CLASS*

Time: 2½ hours

STANDARD VIII

1. (a) Show how the specific gravity of a quantity of sand may be ascertained.
(b) Describe the construction of an hydrometer, state the principles governing its use and show how a rise or fall in the mercury of the thermometer or barometer will affect its reading.
2. Three bodies are thrown vertically upwards. The first began to fall at the end of the third second; the second rises 256 feet before falling; the third has a velocity of 100 feet at the end of the third second. Determine the original velocity of each. (Acceleration due to gravity is 16 feet.)
3. A standing tree is said to possess energy.
(a) How was this energy acquired?
(b) How may it be transformed into kinetic energy?
(c) Will the kinetic energy resulting from the transformation be mechanical or molecular? Explain.
4. Give a scientific explanation of the causes which produce any three of the following phenomena: Dew, summer frosts, lightning, rainbows, mirages, geysers.
5. Write a brief description of the phonograph and show how it differs essentially from the telephone in construction and operation.
6. Show how temperature, atmospheric pressure and wind affect the velocity of sound.
7. A convex lens is placed in the path of a horizontal beam of light. The light is thrown upon a white screen erected in a dark room.
(a) By means of a diagram show the path taken by the light. Where is the light brightest? Why?
(b) If a transparent picture is placed behind the lens show where the screen must be placed to obtain a distinct image.
(c) Compare the image formed in (b) with the original picture and account for the resemblances and differences.

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1897.

7. (d) If the picture is removed and a circular opaque disk is placed some distance in front of the lens, describe and account for the properties of the shadow formed.
(e) How will the shadow be affected by moving (a) the lens, (b) the screen? Why?
8. What is a solar spectrum? How is it obtained? What inferences regarding the properties of light may be inferred from it?
9. Cells are combined into batteries either to secure a greater E.M.F. or to diminish the internal resistance.
(a) Explain the meaning of the term E.M.F.
(b) What is the cause of the internal resistance?
(c) How much cells be combined to produce these results?
10. Describe the process of electroplating.

PHYSICS - FIRST CLASS *

1900

Time: 2½ hours

1. Define velocity and acceleration. Neglecting friction, find the acceleration of a ball of lead (Sp. Gr. 11.3) sinking in water, and a ball of wood (Sp. Gr. 0.6) rising in water.
2. A ship sailing in a southward current is heading in a due east direction from a lighthouse. At the end of four hours the ship is found to have gone 40 miles in a direction 30° south of east. Find the rate of the current and the velocity of the ship.
3. (a) Explain the relation of cohesion and adhesion to capillary phenomena.
(b) If two glass tubes are inserted, one into water and the other into mercury, describe the surfaces of the liquids in each case (i) inside the tubes, (ii) about the outsides of the tubes.
4. (a) Show that temperature does not always signify quantity of heat.
(b) Upon what does the quantity of heat in a body depend?
(c) Describe at least two methods which tend to establish equalisation of temperature.
5. (a) Upon what principles does the action of the siphon depend?
(b) What is the limit of its action?
(c) Do the arms of a siphon require to be of equal bore?
(d) Show how you would siphon gases lighter than air. Draw diagrams to illustrate your answers.
6. (a) Define what is meant by the "latent heat" of water, and state how you would proceed to measure it experimentally.
(b) What becomes of the kinetic energy required to liquefy ice? Explain.
(c) Some ice is to be kept as long as possible in a warm room. Describe giving reasons for the construction of a suitable box.
7. (a) In what respect do dynamo electric machines differ from electromagnetic machines?

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1900.

7. (b) Where does the magnetism of the field magnets come from in the former?
(c) Where does the dynamical energy of the currents come from in the latter?
8. There are 20 cells (E.M.F. = 1.5 volt; $r = 0.5$ ohm each) in a circuit in which the external resistance is 10 ohms. Find the strength of the current which flows (a) when the cells are joined in simple series; (b) when the cells are arranged in multiple arc; (c) when the cells are arranged two abreast.
9. (a) Distinguish forced and sympathetic vibrations.
(b) Show how each is produced.
(c) How many sound waves unite to produce a sound louder or weaker than either above would produce, or to cause silence?
10. (a) Distinguish between a shadow and an image.
(b) Show how each is produced.
(c) Place a lighted candle in an otherwise dark room some distance from a concave mirror and determine the position of the focus of the light waves,
(i) when the candle is brought nearer the mirror,
(ii) when the flame is between the centre of curvature and the principal focus,
(iii) when the flame is at the principal focus.
Give reasons for your answer in each case.
11. (a) How may a ray of white light be (i) decomposed, (ii) recomposed.
(b) Upon what does colour depend?
(c) Explain how the colour of a substance may be analysed.
(d) Why are the colour tints at sunset red and yellow?
(e) Explain the phenomena of the rainbow.

PHYSICS - SECOND CLASS *

1900

Note: Credit will be given for neat illustrative drawings.

Time: 2½ hours

1. (a) In flying a kite, what forces are acting upon the kite when it is at rest in the air?
(b) Draw a diagram to illustrate the direction of these forces.
(c) Why is the string not attached to the bottom of the kite?
2. (a) State the law of buoyant force of fluids.
(b) What are the properties of fluids that produce buoyancy?
(c) Describe a method of determining the specific gravity of a sponge?
(d) A kilogram of iron (Sp. Gr. 7.5) floats in mercury (Sp. Gr. 13.6). Find the volume of the iron above the surface of the mercury.
3. (a) Describe the construction of the mercurial air pump and explain its action.
(b) Where lies the advantage over the piston rod air pump?
4. (a) Explain the advantage gained by using a moveable pulley instead of a fixed pulley.
(b) Show that this advantage may act as a corresponding loss.
5. A man weighing 150 pounds stands in a scale attached to a moveable pulley, and a rope having one end fixed passes under this pulley and over a fixed pulley. Find what force the man must exert on the free end of the rope, the strings being parallel, in order to support himself.
6. (a) Distinguish distillation, ebullition and vaporisation.
(b) Using diagrams, describe a method of distilling water and state what takes place during the process of distillation.
7. Define electrical potential and prove that the potential of a conductor is the same for all points.
8. (a) What is meant by the resistance of a conductor? show how it may be measured.

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1900.

8. (b) State the reasons how cells should be combined so as to obtain the strongest possible current;
 - (i) when the external resistance is excessive.
 - (ii) when the internal resistance is excessive.
9. Describe and explain the method of preparing electro-type plates.
10. What is meant by a 16 candle power incandescent light?
 - (a) Account for the use of carbon filaments in electric lamps.
 - (b) Show why the length of time during which these lamps may be used is limited.
11. In the ordinary tin whistle what effects have the length of the tube, and the size and position of the openings upon the quality, intensity and pitch of the sounds produced?
12.
 - (a) Account for the differences of the images produced by concave and convex mirrors.
 - (b) Compare the construction and working of the microscope and telescope.
 - (c) Upon what principles does each depend for its effectiveness?

TEACHERS' EXAMINATIONS - NON-PROFESSIONAL

PHYSICS - THIRD CLASS *

1900

Time: 2½ hours

1. (a) Outline the theory of the constitution of matter and cite at least three facts regarding the properties of matter which tend to prove it.
(b) Which is the more porous, solids or liquids? Why?
(c) How does the duration of stress affect the elasticity of a body?
2. A certain body has a volume of 8.8 cc. What will be the upward pressure upon it when immersed:
(a) In water?
(b) In a liquid whose density is 0.87 grams per cc.?
3. (a) State the law of attraction of gravity.
(b) What facts would we require to know or ascertain the weight of the moon?
(c) A man buys tea at Victoria and sells it at Banff; does it gain or lose weight at Banff when weighed
(i) in a spring balance,
(ii) in a set of weight scales?
Give reasons for your answer.
4. (a) What is meant by centre of gravity?
(b) How would you find the centre of gravity of a cube, a ring, a bag of gas lighter than air?
(c) Define the different kinds of equilibrium and give examples of each.
5. (a) Outline the construction of the hydrostatic press and explain its working.
(b) Compare the areas of the pistons of a hydrostatic press when a force of 6.25 centigrams acting on the smaller produces an upward pressure of 5.75 grains in the larger. (Note units used)
6. (a) Describe an experiment to find the atmospheric pressure at sea level.
(b) Describe the construction of an aneroid barometer and explain the principles upon which its action depends.
(c) The readings of barometers at "x" and "y" are 27.6 inches and 29.1 inches; compare the altitudes of these places.

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1900.

7. The areas of the bases of three vessels--one cylindrical, one funnel shaped and one cone shaped--are equal and the vessels are filled to an equal depth with water.
 - (a) Compare the pressure exerted upon the base of each vessel with the weight of water it contains.
 - (b) Compare the liquid pressures exerted upon the sides of these vessels.
 - (c) Show that the pressure exerted upon the object supporting each of these vessels is not identical with the pressure on their bases.
8. Four ounces of hot iron filings and four ounces of hot water at the same temperature are poured on different blocks of ice. Which will melt the more ice? Why?
9. Describe the differences between condensing and non-condensing engines in (a) structure, (b) modes of action, (c) economy of work.
10. Show that the potential energy of a body due to advantage of position is not merely the attraction of gravity.
11. Compare the penetrative powers of a bullet weighing 3 ounces and having a velocity of 800 feet per second and a bullet weighing 4 ounces and having a velocity of 400 feet per second.
12.
 - (a) What is meant by mechanical advantage?
 - (b) State the general law of machines.
 - (c) Having given a balance with unequal arms, a box of weights and a substance to be weighed, how would you determine the weight of the substance by applying the principle of moments?
 - (d) A man carries a bundle at the end of a stick across his shoulder. If the piece of stick between his hand and his shoulder be shortened is the pressure on his shoulder increased or diminished? Is the pressure on the ground affected thereby? Give reasons for your answer.
13.
 - (a) Explain the construction and operation of a mercurial thermometer.
 - (b) Why is mercury preferably used for registering high temperatures?
 - (c) When a Farenheit thermometer reads (a) -9° , (b) 76° , what are the corresponding readings on a Centigrade thermometer?

STANDARD VI

Time: 2½ hours

PHYSICS*

1903

1. (a) Distinguish the three states of matter.
(b) State the properties of solids.
(c) Which of the properties of solids do each of the following bodies possess in order to make them useful for the purposes indicated? wool for clothing; glass for windows; steel for bridges; felt for shoes; rubber for tubing; carbon for electric lamps.
2. Outline the molecular theory of the constitution of matter and show how this theory offers an explanation of the states in which matter exists.
3. (a) Outline motion, velocity and acceleration.
(b) Show that when the acceleration is uniform the average velocity during any interval is equal to half the sum of the initial and final velocities of that interval.
(c) A particle which is uniformly accelerated has at the beginning of a minute a velocity of 10 feet per minute and at the end a velocity of 10 feet per second. What is the acceleration? What is the average velocity? How far does it go during the minute?
4. (a) Explain clearly the meaning of the terms, work, energy and force.
(b) By means of a simple illustration show how energy may be transferred and transmuted.
(c) Describe at least two experiments that prove the mutual attraction between the molecules of bodies.
5. (a) Why is a cube said to be more stable than a sphere?
(b) Which of the following is more easily rolled? Why?
 - (i) Two spheres of equal diameters but different masses.
 - (ii) Two spheres of equal masses but of different diameters.
6. (a) Take two similar U-shaped tubes and having one arm of capillary bore. Half fill one with mercury and the other with water. Account for the forms of the surfaces and differences of levels in the tubes.
(b) How does an ordinary oil lamp illustrate the principles of capillarity, change of state, and transformation of energy?

*Taken from the Annual Report of the Department of Education of the North West Territories, 1903.

STANDARD VI PHYSICS (continued)

1903

7. (a) What is meant by buoyancy? What is the relation between buoyancy and density of a liquid? Compare the buoyant effect of a liquid (1) two inches, (2) two feet, below its free surface.
(b) Outline an experiment showing how you would determine the buoyancy of a liquid.
(c) Is the buoyant effort of a liquid the same upon all immersed bodies? Why?
8. (a) Explain the processes of osmosis and dialysis of liquids.
(b) Show that gases may be diffused and absorbed.
(c) Explain the importance to life of the diffusion of gases.
9. (a) Describe the hydrometer under the following headings: construction, use, limit of action.
(b) The specific gravity of gold is 19.3 and quartz 2.65. A nugget of gold quartz weighs 350 grams in air and 302.7 grams in water. Find the volume and mass of gold in the nugget.
10. (a) Distinguish between conduction, convection and radiation of heat. Show the part each plays in a system of hot water heating.
(b) Explain the construction and operation of a thermometer. What are the advantages and disadvantages when spirits are used instead of mercury?

STANDARD VIII

PHYSICS

1903

1. (a) State the laws of liquid pressure.
(b) How is liquid pressure against the sides and bottom of a containing vessel estimated? Illustrate how this applies to vessels of different shapes.
2. A is a closed cubical tank one of whose inside dimensions is 10 cm. Leading from its side is a tube B whose top is 50 cm. above the interior top surface of the tank.
(a) What will be the pressure on the entire bottom of the tank?
(b) What mass of water will the tank contain?
(c) What will be the pressure on one of the sides of the tank?
(d) What will be the pressure on the top of the tank when (1) the tank alone is filled with water.
(2) the tank and tube are filled with water?
3. (a) State the laws of motion.
(b) Explain and illustrate by diagram the direction of the trade winds.
4. (a) Taking a watch as an example, give illustrations of kinetic energy, potential energy, work, force and velocity and show their relations to one another.
(b) What are the units of work and of energy? How are they estimated?
(c) 3,000 cubic feet of water per second flow over a bank 12 feet high. What power does it represent?
5. (a) Describe an experiment to show that increase in pressure raises the boiling point of liquids.
(b) If a kilogram of ice at 0° C. be changed into steam at 100° C., how much of the heat is rendered latent? How much remains as sensible heat?
6. (a) Explain the relations which the properties of a sound wave bear to the properties of a sound sensation.
(b) Distinguish the motion of a sound wave from the motion of the air particles which at any instant constitute such wave?
(c) What are the effects of temperature, density, elevation, and wind upon the velocity of sound?
(d) Show the difference between discord and harmony.

STANDARD VIII PHYSICS (continued)

7. (a) Explain the position of the image and the kind of image formed with a convex mirror when an object is placed, (1) beyond the centre of curvature, (2) between the centre of curvature and the principal focus, (3) between the principal focus and the mirror.
8. (a) "Color is not a property of any body." Explain.
(b) What is the cause of color blindness?
(c) Account for the prevalence of yellow and red tints at sunset.
9. (a) Outline the construction and operation of a dynamo.
(b) How may a dynamo be converted into a motor?
(c) Define: ampere, volt, ohm. State their interdependence.
10. (a) What is a magnet? Explain the different methods of magnetization.
(b) Iron filings are scattered over a sheet of paper. Sketch and account for the forms assumed when (1) a magnet is held laterally under the sheet of paper and (2) the N poles of two magnets are placed an inch apart below the paper.

DEPARTMENTAL EXAMINATIONS

Time: 3 hours

PHYSICS 2*

1926

VALUES

- 5 1. (a) By using a diagram describe the construction of a vernier caliper and indicate how to use it in making a fine measurement.
- 5 (b) Define the terms gram, poundal, erg, horsepower, watt.
- 4 2. (a) Deduce the formula $S = UT + \frac{1}{2}at^2$
- 5 (b) Describe a method for determining the acceleration in the velocity of a falling body.
- 5 (c) A stone is dropped into a mine shaft and 9 seconds after, the sound of the stone striking the bottom is heard. How deep is the shaft?
(Sound travels 1024 ft. per sec. and $g=32$.)
- 6 3. (a) State Newton's three laws of motion and give one clear illustration of each.
- 5 (b) Describe the construction and operation of either a Cream Separator or the differential in a motor car. Use a diagram.
- 4 (c) What force parallel to the plane is necessary to keep a mass of 100 lbs. at rest on a smooth inclined plane rising 3 ft. in 5?
- 2 4. (a) What is Coefficient of Friction?
- 3 (b) Describe a method of determining the coefficient of friction between two surfaces.
- 3 (c) What is meant by saying that the static coefficient of friction is greater than the kinetic?
- 5 5. (a) A ladder 50 feet long having a mass of 100 lbs. is carried by two men; one lifts at one end and the other lifts at a point 2 feet from the other end. The first carries $\frac{2}{3}$ of the weight that the second bears. Where is the centre of gravity of the ladder?
- 5 (b) A mass of 20 lbs. hanging at the end of a light cord 16 feet long is drawn aside through an angle of 30° and then let go. Find its kinetic energy in foot poundals when it reaches its lowest point.

DEPARTMENTAL EXAMINATIONS, 1926, PHYSICS 2 (continued)

VALUES

- 4 6. (a) Explain the action of the differential pulley.
3 (b) Demonstrate how the ordinary screw is an adaptation of the inclined plane.
- 5 7. (a) Apply "Pascal's Principle" to explain
4 "Archimedes' Principle".
(b) A piece of iron weighing 263.5 grams weighs in water 226.4 grams. It is placed in a vessel of mercury whose specific gravity is 13.6. How deep does the iron sink into the mercury?
- 3 8. (a) What is the kinetic theory of gases?
4 (b) Oxygen gas is contained in a cylinder having a volume of 6 cu. ft. under a pressure of 15 atmospheres. Some of the gas is used reducing the pressure to 5 atmospheres. At 6 cents per cu. ft. measured at atmospheric pressure what value of gas was used from the cylinder?
- 5 9. (a) Prove that the height to which a liquid may be drawn upwards in a capillary tube, wetted by the liquid, is inversely proportional to the radius of the tube.
5 (b) Describe an experiment to show clearly that when certain substances are dissolved in water the surface tension of the solution is less than that of pure water.
- 5 10. (a) Prove that the velocity of a mobile liquid flowing through an orifice in a vessel is the same as would be acquired by the liquid falling through the distance that the orifice is below the surface of the liquid.
5 (b) Explain why it is dangerous for large ships to manœuvre too closely to one another.

APPENDIX C

PROGRAMS OF STUDIES

- Non-Professional Examinations, Standard V, 1896
- Outline of the Prescribed Course in Physics, Standard VI, 1900
- The Revised Program of Studies for 1902 (Standards VI, VII and VIII)
- Program of Studies, Standards VI, VII, VIII and Normal School, Province of Alberta, 1906
- Program of Studies, Standards VI, VII and VIII, Province of Alberta, 1906 - 1907 to 1910 - 1911
- Program of Studies, Grades IX, X, XI and XII, Province of Alberta, 1912
- The Alberta High School Program in Physics 1913 - 14 According to Chapter Titles from the Prescribed Textbooks (Grades IX, X, XI, XII)
- The Physics Section of the Grade IX Course in Elementary Science 1912
- Grade IX Physics Portion of Elementary Science, 1914
- Proposed Requirements for Selected High School Courses, Province of Alberta, 1923
- Course Outline for Chemistry I, 1925
- Course Outline for Chemistry II, 1925
- Course Outline for Physics I, 1925
- Course Outline for Physics II, 1925
- The Grade IX Course in General Science I - 1931

NON-PROFESSIONAL EXAMINATIONS *

STANDARD V

1896

THIRD CLASS

Physics - The elements of physics.

Textbook: Gage's Introduction to Physical Science,
Chapters I, II, III and IV.

SECOND CLASS

Physics - The elements of physics.

Textbook: Gage's Introduction to Physical Science
(Ginn and Company)

FIRST CLASS

Chemistry

Textbook: Kirkland's Experimental Chemistry
(Gage and Company)

Physics - Textbook: Gage's Introduction to Physical Science
(Ginn and Company)

*Report of the Council of Public Instruction of the North West Territories of Canada, together with the Report of the Superintendent of Education and Appendices, 1896, pp. 16 - 17.

OUTLINE OF THE PRESCRIBED COURSE IN PHYSICS

STANDARD VI - 1900*

13. PHYSICS - The course in this subject shall cover the following -
 - (a) Metric and English systems of measures.
 - (b) Matter: Solid, fluid (liquid, gas), constitution of matter.
 - (c) Properties and laws of solids: Hardness, ductility, malleability, plasticity, cohesion, adhesion, elasticity, structure (crystalline and amorphous).
 - (d) Properties and laws of liquids: Fluidity; viscosity; cohesion, adhesion; capillary phenomena; surface tension, transmission of pressure by fluids; pressure due to weight; surface of a liquid at rest under the action of gravity; buoyancy.
 - (e) Properties and laws of gases: Pressure due to weight; expansion force (tension or elastic force); buoyancy; measurements of the pressure of the atmosphere, barometer; compressibility; Boyle's or Mariotte's Law.
 - (f) Construction and action of the following instruments and machines: Air pump (common and Sprengel), condenser, common pump, force pump, siphon and hydrostatic press.
 - (g) Specific gravity and density of a solid, liquid and gas.
 - (h) Relative motion and absolute rest
 - Force: Definition; recognition; manifestations; measurement; stress, action, reaction; molar and molecular forces; moment of a force; unit of force and mass.
 - (i) Energy: Definition; relation to force; various forms, potential and kinetic.
 - Work: Definitions; relation to energy and force, wasted work; unit; estimation of work done.
 - (j) Newton's Three Laws of Motion and their application to universal gravitation; equilibrium of bodies.

*Taken from the Report of the Council of Public Instruction of the North West Territories, 1900.

- (k) Machines: Uses, advantages, laws; levers, balance, inclined plane, pulleys.
- (l) Heat: Nature and sources; expansion of solids, liquids, gases; measurement of heat; construction and use of thermometer; maximum density of water. Change of state - solid to liquid and liquid to solid; vaporisation and liquefaction; ebullition, evaporation, dew point. Transmission of heat - conduction, convection, radiation.
- (m) Transformation, correlation and conservation of energy.

TEXTBOOK: Gage's INTRODUCTION TO PHYSICAL SCIENCE

THE REVISED PROGRAM OF STUDIES FOR 1902*

STANDARD VI

The obligatory subjects are reading, English composition, English literature, English grammar and rhetoric, history, geography, arithmetic and mensuration, algebra, geometry, botany and drawing.

The optional subjects are bookkeeping, agriculture, physics, Latin, French and German.

Physics - As in Merchant and Fessenden's High School Physical Science, Part I (The Copp Clark Company)

STANDARD VII

The obligatory subjects are reading, English grammar and rhetoric, English composition, English literature, general history, physical geography, algebra, geometry, animal life and drawing.

The optional subjects are chemistry, Latin, French and German.

Normal school students could elect Latin instead of algebra, either French or German instead of chemistry.

Students desiring standing equivalent to Matriculation must select for examination the languages and other subjects prescribed therefor by the University.

Chemistry - As in Waddell's School Chemistry (The Macmillan Company)

STANDARD VIII

The obligatory subjects are reading, English composition, English literature, English language and rhetoric, history and physics.

The optional subjects are algebra, geometry, trigonometry, Latin, French and German.

Physics - The elements of physics.

Textbook: Gage's Introduction to Physical Science
(Revised edition, 1902, Ginn and Company)

*Compiled from the Annual Report of the Department of Education of the North West Territories, 1902, pp. 85 - 89.

PROGRAM OF STUDIES, STANDARDS VI, VII, VIII AND NORMAL SCHOOL
PROVINCE OF ALBERTA, 1906

STANDARD VI	STANDARD VII	STANDARD VIII
<p><u>Physical Science</u>: As in Merchant and Fessenden's <u>High School Physical Science, Part I</u> (Copp Clark Co.)</p> <p><u>Obligatory Subjects</u>: Reading, Eng. Composition, Eng. Literature, Eng. Grammar & Rhetoric, Geography, British & Canadian History, Arithmetic, & Mensuration, Geometry, Botany, Drawing.</p> <p><u>Optional Subjects</u>: Algebra, Bookkeeping, Agriculture, Physical Science, Latin, French and German.</p> <p><u>Examination Subjects</u>: Eng. Literature, Eng. Composition, British & Canadian History, Geography, Arithmetic and Mensuration, Algebra, Bookkeeping, Botany & Agriculture, Physical Science, Drawing.</p>	<p><u>Chemistry</u>: As in Waddell's <u>School Chemistry</u>, especially Chapters I to XIV inclusive (Morang and Co.)</p> <p><u>Obligatory Subjects</u>: Reading, Eng. Composition, Eng. Literature, General History, Physical Geography, Animal Life, Geometry, Drawing.</p> <p><u>Optional Subjects</u>: Eng. Grammar and Rhetoric, Algebra, Chemistry, Latin, French and German.</p> <p><u>Examination Subjects</u>: English Composition, Eng. Literature, General History, Physical Geography, Geometry, Animal Life, and <u>any 2</u> of: Algebra, Eng. Grammar & Rhetoric, Chemistry, Latin, French and German.</p>	<p><u>Physical Science</u>: The Elements of Physics. Textbook: Gage's <u>Introduction to Physical Science, Revised Edition, 1902</u> (Ginn & Co.)</p> <p><u>Obligatory Subjects</u>: Reading, Eng. Composition, Eng. Literature, Eng. Language & Rhetoric, History and Trigonometry.</p> <p><u>Optional Subjects</u>: Algebra, Geometry, Physical Science, Latin French and German.</p> <p><u>Examination Subjects</u>: English Composition, Eng. Literature, Eng. Language and Rhetoric, Trigonometry and <u>any 2</u> of: Physical Science, Algebra, Geometry, Latin, French or German.</p>

Note: Students desiring to proceed to University were cautioned to select the languages and other subjects necessary to meet the matriculation requirements of the University.

PROGRAM OF STUDIES, STANDARDS VI, VII AND VIII
PROVINCE OF ALBERTA, 1906 - 1907 to 1910 - 1911

STANDARD VI	STANDARD VII	STANDARD VIII
<p><u>Physical Science</u>: As in Chapters I to X inclusive of <u>High School Physical Science</u>. Part I, Revised Edition (Copp Clark Company)</p> <p><u>Obligatory Subjects</u>: Eng. Literature, Eng. Composition, British & Canadian History, Geography, Arithmetic and Mensuration, Botany & Agriculture, Drawing.</p> <p><u>Optional Subjects</u>: Algebra Bookkeeping, Agriculture, Physical Science, Latin, French and German.</p> <p><u>Exam. Subjects for the Standard VI Diploma</u>: Eng. Literature, Eng. Composition, British & Canadian History, Geography, Arithmetic & Mensuration, Algebra, Bookkeeping, Botany & Agriculture, Physical Science, Drawing</p>	<p><u>Physical Science</u>: Merchant and Fessenden's <u>High School Physical Science</u>, Part I, Revised Edition (Copp Clark Company)</p> <p><u>Chemistry</u>: Mills' <u>Chemistry for Schools</u> (Gage and Company)</p> <p><u>Obligatory Subjects</u>: Reading Eng. Composition, Eng. Literature, History, Eng. Grammar & Rhetoric, Animal Life, Geometry, Arithmetic and Mensuration.</p> <p><u>Optional Subjects</u>: Physical Science, Algebra, Chemistry, Latin and French.</p> <p><u>Exam. Subjects for the Standard VII Diploma</u>: Eng. Composition, Eng. Literature, History, Eng. Grammar & Rhetoric, Geometry, Animal Life, Arithmetic & Mensuration, and any 3 of: Algebra, Physical Science, Chemistry, Latin, French and German.</p>	<p><u>Physical Science</u>: The Elements of Physics. Textbook: <u>High School Physical Science</u>, Part II, Revised Edition (Copp Clark Company)</p> <p><u>Chemistry</u>: Inorganic Chemistry - Remsen's <u>Briefer Course</u> (Henry Holt & Company)</p> <p><u>Obligatory Subjects</u>: Reading, Eng. Composition, Eng. Literature, Eng. Language & History of Literature, History and Trigonometry.</p> <p><u>Optional Subjects</u>: Algebra, Geometry, Chemistry, Physical Science, Latin, French, German.</p> <p><u>Exam. Subjects for the Standard VIII Diploma</u>: Eng. Composition, Eng. Literature (2 papers), Eng. Language & History of Literature, History, Trigonometry, <u>either</u> Physical Science or Chemistry, and any 2 of: Algebra, Geometry, Latin, French and German.</p>

Note: Students desiring to proceed to University were cautioned to select the languages and other subjects necessary to meet the matriculations requirements of the University.

PROGRAM OF STUDIES, GRADES IX, X, XI AND XII
PROVINCE OF ALBERTA, 1912

GRADE IX	GRADE X
<p><u>Elementary Science:</u></p> <p>a) Botany; b) Zoology; *c) Physics: Measurements, mass, density, specific gravity, properties and states of matter, motion energy and work, simple machines, pressures in liquids and gases, molecular theory. <u>Textbook: Merchant and Chant's High School Physics</u> (Copp Clark Co.)</p> <p><u>Obligatory Subjects:</u> Eng. Literature, Composition, Writing, History, Geography, Arithmetic & Mensuration, Algebra, Geometry, Drawing and Elementary Science.</p> <p><u>Optional Subjects:</u> Latin, French and German.</p> <p><u>Examination Subjects for the Grade IX Diploma:</u> Eng. Literature, Composition, Grammar, History, Geography, Arithmetic & Mensuration, Algebra, Geometry and Elementary Science.</p> <p>(Papers were also provided in Latin, French and German and candidates looking forward to University matriculation were advised to take the examination in such languages as their prospective course demanded.)</p> <p>*See Appendix C, page 199 for detailed outline.</p>	<p><u>Elementary Science:</u></p> <p>a) Botany; b) Zoology; c) Physics: Review of course prescribed for Grade IX; nature and sources of heat, expansion through heat, temperature, relation between volume and temperature, measurement of heat, fusion and vaporization, heat and mechanical motion, transference of heat; magnetism, electric currents, chemical effects and magnetic relations of electric currents, heating and lighting effects of currents, induced currents and their applications, electrical measurements, other forms of radiant energy with applications.</p> <p><u>Textbook: Merchant and Chant's High School Physics</u> (Copp Clark)</p> <p><u>Obligatory Subjects:</u> Eng. Literature, Composition, Grammar, History, Physical Geography, Arithmetic & Mensuration, Algebra, Geometry, Drawing and Elementary Science.</p> <p><u>Optional Subjects:</u> Latin, French, German & Greek.</p> <p><u>Examination Subjects for the Grade X Diploma:</u> Eng. Literature, Composition, Grammar, History, Physical Geography, Arithmetic & Mensuration, Algebra, Geometry, Elementary Science and Drawing.</p> <p>(Papers were also provided for prospective matriculants requiring Latin, French, German or Greek.</p>

GRADE XI	GRADE XII
<p><u>Chemistry: The course is to be experimental as far as possible.</u></p> <p>Physical and chemical changes; elements, compounds, mixtures & solutions; fundamental chemical laws & principles, e.g. definite proportions, multiple proportions, constancy of mass and equivalence; Avogadro's hypothesis and its applications; ionization in solution; properties of acids, bases & salts; types of chemical reaction, e.g. oxidation, reduction, replacement; neutralization of acids & bases, catalytic action, combination in solutions; the practical study of the following elements and their more important compounds for the purpose of learning their chemical properties & relationships, illustrating the laws & principles of chemistry, and learning something of the commercial & industrial uses & preparations of materials derived from them, e.g. hydrogen, oxygen, sulphur, sodium, potassium, nitrogen, phosphorus, chlorine, bromine, iodine, carbon, calcium, iron and aluminum.</p> <p><u>Textbook: Mills' Chemistry for Schools</u> (Gage & Co.)</p>	<p><u>Chemistry: Inorganic Chemistry - Remsen's Briefer Course</u> (Holt and Co.)</p> <p><u>Physics: High School Physical Science, Part II</u>, Revised Edition (Copp Clark Co.)</p> <p>Sound, light, magnetism, and electricity.**</p>
<p><u>Physics: A general knowledge of the subject as contained in Merchant & Fessenden's High School Physical Science, Part I, Revised Edition.</u></p> <p><u>Obligatory Subjects:</u></p> <p>Eng. Literature, Composition & Rhetoric, History, Algebra, Geometry, Chemistry and Animal Life.</p> <p><u>Optional Subjects:</u></p> <p>Physics, Latin, French, German, Greek</p> <p><u>Examination Subjects for the Grade XI Diploma:</u> Eng. Literature, Composition and Rhetoric, History, Algebra, Geometry, Chemistry and Animal Life.</p> <p>(Papers provided in optional subjects)</p>	<p><u>Obligatory Subjects:</u></p> <p>Eng. Literature, Composition and Rhetoric, Eng. Language & History of Literature, History, Algebra, Geometry, Trigonometry, Chemistry, Physics, Latin, French, German and Greek.</p> <p><u>Optional Subjects:</u></p> <p>None listed, but note requirements for Grade XII Diploma below.</p> <p><u>Examination Subjects for the Grade XII Diploma:</u></p> <p>Eng. Literature (two papers), Composition and Rhetoric, Eng. Language and History of Literature, History, Trigonometry, <u>either</u> Physical Science or Chemistry and any <u>two</u> of the following: Algebra, Geometry, Latin, French, German or Greek.</p> <p>**Taken from the Table of Contents of the Authorized Text.</p>

THE ALBERTA HIGH SCHOOL PROGRAM IN PHYSICS 1913 - 14
ACCORDING TO CHAPTER TITLES FROM THE PRESCRIBED TEXTBOOKS

GRADE IX

Textbook: Merchant and Chant, High School Physics

CHAPTER

- I MEASUREMENT
 - II DISPLACEMENT, VELOCITY (omitting Sections 24 to 38 inclusive)
 - III INTERIA, MOMENTUM, FORCE (omitting Sections 46-49)
 - VI WORK AND ENERGY (omitting Sections 68 and 69)
 - VII CENTRE OF GRAVITY
 - VIII FRICTION
 - IX MACHINES (Omitting Sections 87, and 90-94 inclusive)
 - X PRESSURE OF LIQUIDS
 - XI BUOYANCY OF FLUIDS
 - XIII PRESSURE IN GASES
 - XIV APPLICATION OF THE LAWS OF GASES
-

GRADE X

Textbook: Merchant and Chant, High School Physics

CHAPTER

- REVIEW OF GRADE IX COURSE
- XII DETERMINATION OF DENSITY
- XV THE MOLECULAR THEORY OF MATTER
- XVI MOLECULAR FORCES IN SOLIDS AND LIQUIDS
- XVII PHENOMENA OF SURFACE TENSION AND CAPILLARITY
- XXIV NATURE AND SOURCES OF HEAT
- XXV EXPANSION THROUGH HEAT
- XXVI TEMPERATURE
- XXVII RELATION BETWEEN VOLUME AND TEMPERATURE
- XXVIII MEASUREMENT OF HEAT
- XXIX CHANGE OF STATE
- XXX HEAT AND MECHANICAL MOTION
- XXXI TRANSFERENCE OF HEAT

THE ALBERTA HIGH SCHOOL PROGRAM IN PHYSICS 1913-14 (continued)

Grade XITextbook: Merchant and Chant, High School Physics

CHAPTER

REVIEW OF WORK OF PREVIOUS GRADES

- XVIII WAVE MOTION
 - XIX PRODUCTION, PROPAGATION, VELOCITY OF SOUND
 - XX PITCH, MUSICAL SCALES
 - XXI VIBRATIONS OF STRINGS, RODS, PLATES AND AIR COLUMNS
 - XXII QUALITY, VIBRATING FLAMES, BEATS
 - XXIII MUSICAL INSTRUMENTS - THE PHONOGRAPH
 - XXXII THE NATURE OF LIGHT: ITS MOTION IN STRAIGHT LINES
 - XXXIII PHOTOMETRY
 - XXXIV THE VELOCITY OF LIGHT
 - XXXV REFLECTION OF LIGHT: PLANE MIRRORS
 - XXXVI REFLECTION FROM CURVED MIRRORS
 - XXXVII REFRACTION
 - XXXVIII LENSES
 - XXXIX DISPERSION, COLOUR, THE SPECTRUM, SPECTRUM ANALYSIS
 - XLII ELECTRICITY AT REST
 - XLIII THE ELECTRIC CURRENT
 - XLIV CHEMICAL EFFECTS OF THE ELECTRIC CURRENT
 - XLV MAGNETIC RELATIONS OF THE CURRENT
-

GRADE XIITextbook: Merchant, High School Physical Science, Part II,
Revised Edition, 1906.

CHAPTER

- I ORIGIN AND TRANSMISSION OF SOUND
- II INTENSITY, REFLECTION, REFRACTION AND INTERFERENCE OF SOUND WAVES
- III PITCH OF SOUNDS - MUSICAL SCALES
- IV TRANSVERSE VIBRATIONS OF STRINGS
- V VIBRATION OF AIR IN TUBES - RESONANCE
- VI NATURE AND PROPAGATION OF LIGHT

THE ALBERTA HIGH SCHOOL PROGRAM IN PHYSICS 1913-14 (continued)
GRADE XII (continued)

CHAPTER

- VII PHOTOMETRY
- VIII REFLECTION OF LIGHT
- IX REFRACTION OF LIGHT
- X DISPERSION OF LIGHT COLOUR
- XI MAGNETISM
- XII THE ELECTRIC CURRENT
- XIII THE CHEMICAL EFFECTS OF THE ELECTRIC CURRENT
- XIV THE MAGNETIC EFFECTS OF THE CURRENT
- XV CURRENT INDUCTION
- XVI HEATING AND LIGHTING EFFECTS OF THE ELECTRIC CURRENT
- XVII ELECTRICAL MEASUREMENTS

THE PHYSICS SECTION OF THE GRADE IX COURSE
IN ELEMENTARY SCIENCE 1912

Textbook: Merchant and Chant's High School Physics, 1911
Edition

CHAPTER I MEASUREMENT

1) Physical Quantities; 2) Measuring a Quantity; 3) Fundamental Units; 4) Standards of Length - the Yard; 5) The Metre; 6) National Standards; 7) The Metre Independent of the Size of the Earth; 8) Sub-divisions of the Metre; 9) Relation of Metres to Yards; 10) Derived Units; 11) Standards of Mass; 12) Unit of Time; 13) English and C.G.S. System; 14) Measurement of Length; 15) Measurement of Mass; 16) Sets of Weights; 17) Density; 18) Relation between Density and Specific Gravity.

CHAPTER II DISPLACEMENT, VELOCITY

19) Position of a Point; 20) Displacement; 21) Velocity; 22) Uniform Velocity in a Straight Line; 23) Acceleration.

CHAPTER III INERTIA, MOMENTUM, FORCE

39) Mass, Inertia; 40) Momentum; 41) Newton's Laws of Motion: the First Law; 42) Illustrations of the First Law; 43) Newton's Second Law of Motion; 44) Units of Force, 45) Average Force.

CHAPTER VI WORK AND ENERGY

63) Definition of Work; 64) Units of Work; 65) How to Calculate Work; 66) Definition of Energy; 67) Transformations of Energy; 70) Matter, Energy, Force; 71) Power.

CHAPTER VII CENTRE OF GRAVITY

72) Definition of Centre of Gravity; 73) To Find the Centre of Gravity Experimentally; 74) Centre of Gravity of Some Bodies of Simple Form; 75) Condition for Equilibrium; 76) The Three States of Equilibrium.

CHAPTER VIII FRICTION

77) Friction Stops Motion; 78) Every Surface is Rough; 79) Laws of Sliding Friction; 80) Rolling Friction.

CHAPTER IX MACHINES

81) Object of a Machine; 82) The Lever: First Class; 83) The Lever: Second Class; 84) The Lever: Third Class; 85) The Pulley; 86) A Single Movable Pulley; 88) The Wheel and Axle; 89) Examples of Wheel and Axle.

THE PHYSICS SECTION OF THE GRADE IX COURSE
IN ELEMENTARY SCIENCE 1912 (continued)

CHAPTER X PRESSURE OF LIQUIDS

95) Transmission of Pressure by Fluids; 96) Practical Applications of Pascal's Law; 97) Hydraulic Press; 98) The Hydraulic Elevator; 99) Canal Lift-lock; 100) Pressure due to Weight; 101) Relation Between Pressure and Depth; 102) Pressure Equal in all Directions at Same Depth; 103) Magnitude of Pressure Due to Weight; 104) Explanation of the Paradox; 105) Surface of a Liquid in Connecting Tubes; 106) Artesian Wells.

CHAPTER XI BUOYANCY OF FLUIDS

107) Nature of Buoyancy; 108) To Determine Experimentally the Amount of the Buoyance Force Which a Liquid Exerts on an Immersed Body; 109) Principle of Flotation.

CHAPTER XIII PRESSURE IN GASES

115) Has Air Weight; 116) Pressure of Air; 117) The Terricellian Experiment; 118) The Barometer; 119) The Cistern Barometer; 120) The Siphon Barometer; 121) The Aneroid Barometer; 123) Practical Value of the Abrometer; Atmospheric Pressure; 123) Variations in Atmospheric Pressure; 124) Construction of the Weather Map; 125) Elementary Principles of Forecasting; 126) Determination of Elevation; 127) The Height of Atmosphere; 128) Compressibility and Expansibility of Air; 129) The Relation Between Volume and Pressure of Air - Boyle's Law; 130) Buoyancy of Gases; 131) Balloons.

CHAPTER XIV APPLICATIONS OF THE LAWS OF GASES

132) Air-Pump; 133) The Geryk or Oil Air-Pump; 134) Mercury Air-Pump; 135) Bunset Jet Pump; 136) The Hydraulic Air-Compressor; 137) Air Condenser; 138) Uses of Compressed Air; 139) Air Brakes; 140) Diving Bells and Diving Suits; 141) Water Pumps; 142) Suction or Lift-Pump; 143) Force-Pump; 144) Double Action Force-Pump; 145) Siphon; 146) The Aspirating Siphon.

Textbook: Merchant, F. W. and Chant, C. A. Elementary Physics for High Schools. (Toronto: The Copp Clark Co., 1914). Chapters I - XIV, pages 1 - 95 inclusive.

PART I INTRODUCTION

CHAPTER

I MEASUREMENTS (I)

1) Science in Daily Life; 2) Fundamental Units; 3) Standards of Length - The Yard; 4) The Metre; 5) Sub-divisions and Multiples of the Metre; 6) Relation between Metres and Yards; 7) Units of Surface and Volume; 8) Standards of Mass; 9) Unit of Time; 10) Measurement of Length; 11) More Accurate Measurements; 12) Measurement of Mass; 13) Sets of Weights; 14) Rules for the Use of the Balance; 15) Density; 16) Relation between Density and Specific Gravity.

PART II MECHANICS OF SOLIDS - BODIES AT REST AND IN MOTION

II VELOCITY, ACCELERATION (II)

17) Rest and Motion; 18) Velocity or Speed; 19) Acceleration; 20) Space Passed Over; 21) All Bodies if Unimpeded Fall at the Same Rate.

III MOMENTUM, FORCE (III)

22) Mass and Velocity Combined; 23) Momentum; 24) Force; 25) Force and Momentum; 26) Motion of the Planets; 27) Action and Reaction; 28) Experimental Illustration of Action and Reaction; 29) Combination of Forces.

IV GRAVITATION (V)

30) Law of Gravitation; 31) All Bodies Attract Each Other; 32) The Weight of a Body.

V WORK AND ENERGY (VI)

33) Meaning of Work; 34) Units of Work; 35) How to Calculate Work; 36) Definition of Energy; 37) Transformation of Energy; 38) Matter, Energy, Force; 39) Power

() The number within the brackets following each chapter title denotes the chapter from High School Physics by Merchant and Chant in which the same topics are discussed.

GRADE IX PHYSICS PORTION OF ELEMENTARY SCIENCE, 1914 (continued)

CHAPTER

VI CENTRE OF GRAVITY (VII)

40) Definition of Centre of Gravity; 41) To Find the Centre of Gravity Experimentally; 42) Bodies of Simple Form; 43) Condition for Equilibrium; 44) Three States of Equilibrium.

VII FRICTION (VIII)

45) Friction Stops Motion; 46) Every Surface is Rough; 47) Rolling Friction.

VIII MACHINES (IX)

48) Machines, 49) The Lever: First Class; 50) The Lever: Second Class; 51) The Lever: Third Class; 52) The Pulley; 54) The Wheel and Axle; 55) Examples of Wheel and Axle.

PART III MECHANICS OF FLUIDS: LIQUIDS AND GASES AT REST AND IN MOTION

IX PRESSURE OF LIQUIDS (X)

56) Transmission of Pressure by Fluids; 57) Practical Applications; 58) Hydraulic Press; 59) The Hydraulic Elevator;* 60) Canal Lift-Lock;* 61) Pressure Due to Weight; 62) Relation between Pressure and Depth; 63) Pressure Equal in all Directions at the Same Depth; 64) Magnitude of Pressure Due to Weight; 65) Surface of a Liquid in Connecting Tubes; 66) Artesian Wells.

X BUOYANCE OF FLUIDS (XI)

67) Buoyant Action of a Fluid; 68) To Determine the Amount of the Buoyant Force; 69) Will a Body Float or Sink?

XI DETERMINATION OF DENSITY (XII)

70) Density of a Solid Heavier than Water; 71) Density of a Solid Lighter than Water; 72) Density of a Liquid by the Specific Gravity Bottle; 73) The Hydrometer.

XII PRESSURE IN GASES (XIII)

74) Has Air Weight? 75) Pressure of Air; 76) How to Measure the Pressure of the Atmosphere;

*Denote a section in fine print. (There was no preface to this book and no indication of the significance of the fine print. In previous editions of physics texts, this was used to indicate an optional or enrichment topic.)

GRADE IX PHYSICS PORTION OF ELEMENTARY SCIENCE, 1914 (continued)
CHAPTER

XII PRESSURE IN GASES (continued)

77) Barometer; 78) Practical Value of the Barometer;
79) Determination of Elevation; 80) Compressibility
and Expansibility of Air; 81) Relation between Volume
and Pressure - Boyle's Law; 82) Buoyancy of Gases;
83) Balloons.*

XIII APPLICATION OF THE LAWS OF GASES (XIV)

84) Air-Pump; 85) Air Condenser; 86) Air-Brakes*;
87) Diving Suits;* 88) Suction or Lift Water Pump;*
89) Force-Pump;* 90) Double Action Force-Pump;*
91) Siphon.

PART IV SOME PROPERTIES OF MATTER

XIV MOLECULES AND THEIR MOTIONS (XV, XVI, XVII)

92) Evidence Suggesting Molecules; 93) Diffusion
of Gases; 94) Diffusion of Liquids and Solids;
95) Passage of Hydrogen through a Porous Wall;
96) Molecular Motions in Liquids; 97) Osmosis;
98) Viscosity; 99) Distinction between Solids and
Liquids; 100) Cohesion and Adhesion; 101) Other
Properties Depending on Cohesion; 102) Forces at
the Surface of a Liquid; 103) Surface Tension in
Soap Films; 104) Levels of Liquids in Capillary
Tubes;* 105) Other Illustrations of Surface Tension;*
106) Small Bodies Testing on the Surface of Water.*

PROPOSED REQUIREMENTS FOR SELECTED HIGH SCHOOL COURSES

PROVINCE OF ALBERTA, 1923*

I. GENERAL COURSES (JUNIOR MATRICULATION)

1. Successful completion of 21 units of work exclusive of physical education;
2. Four units must be English;
3. Six units must be from work prescribed for grades XI and XII;
4. Any extra subjects over and above the minimum were to be entered on the Diploma.

It was suggested that the twenty-one units be distributed as follows:

Grade IX, 6 units; Grade X, 7 units; Grade XI, 8 units.

II. NORMAL ENTRANCE COURSE

A. Required Units (16):

Grade IX	Grade X	Grade XI
English (2)	English (2)	English (2)
General Science	History	Agriculture or
Algebra	Agriculture	Chemistry
Art	or Physics	Arithmetic
	Geometry	Geography
		History & Economics

B. Optional Units (5 to be chosen):

Algebra (1)	Agriculture (2)	Music (1)
Geometry (1)	Latin (2)	Art (1)
History (1)	French (2)	Bookkeeping (1)
Physics and	German (2)	and
Chemistry (2)		Manual Training (2)
		or
		Household Econo-
		mics (2)

III. GRADE XII (FIRST CLASS NON-PROFESSIONAL CERTIFICATE)

Eight units required exclusive of Physical Education

A. Required: English (2 units)

B. Optional: Any 6 of:

History	Trigonometry	Chemistry	German
Algebra	Physics	Latin	Greek
Geometry	Biology	French	

*Compiled from Province of Alberta, Department of Education, Annual Report, 1922, pp. 26 - 27.

COURSE OUTLINE FOR CHEMISTRY I, 1925*

I. INTRODUCTORY:

- (a) The field of chemistry and the importance of the science;
- (b) Physical and Chemical Change - kinds of chemical change, union and decomposition;
- (c) i) Kinds of substances - elements and compounds - distinction between mixtures and compounds;
ii) Elements - occurrences - free and combined - number, distribution and relative importance; classification - metals and non-metals.

II. AN EXPERIMENTAL COURSE DEFINED AS FOLLOWS:

- (a) A study of the elements and their most important compounds:
Hydrogen; oxygen; nitrogen; carbon; sulphur; chlorine; potassium; sodium; calcium;
i) Preparation, physical and chemical properties;
ii) Occurrence, natural and economic importance;
- (b) Air - composition, importance of each constituent;
- (c) Water:
i) Analysis and synthesis;
ii) Inorganic and organic impurities, sources, purification;
iii) Water of crystallization - efflorescence, deliquescence, dehydration;
- (d) Solutions - liquid and gaseous - properties - unsaturated, saturated and supersaturated - solubility curve - effect of change in temperature - precipitation, crystallization, filtration;
- (e) Combustion - ordinary, slow, spontaneous, ignition, temperature, flames of candle and Bunsen burners, oxidation and reduction;
- (f) Oxides, acids, bases, salts - properties - neutralization.

III. GENERAL CHEMISTRY:

- (a) Laws - law of conservation of mass - laws of definite and multiple proportions, Boyle's and Charles' Law, law of combining weights; Gay-Lussac's Law of Volumes;
- (b) Theories: atomic and molecular theories, Avogadro's hypothesis; ionization; value of theories in explaining facts and laws and in discovering new truths;
- (c) Valency: formulae, chemical nomenclature, easy equations;
- (d) Atomic, molecular and combining weights - calculations.

*Taken from the Handbook for Secondary Schools, Alberta, Province of Alberta, Department of Education, 1925.

COURSE OUTLINE FOR CHEMISTRY II, 1925

A. INORGANIC CHEMISTRY

1. (a) A study of the following elements and of their most important compounds:
Hydrogen; helium; lithium; sodium; potassium; copper; silver; gold; calcium; strontium; barium; radium; magnesium; zinc; mercury; boron; aluminium; carbon; silicon; tin; lead; nitrogen; phosphorus; arsenic; antimony; bismuth; chromium; tungsten; oxygen; sulphur; manganese; fluorine; chlorine, bromine; iodine; iron; cobalt; nickel; platinum.
(b) Their occurrence, mineralogy, and metallurgy.
(c) Group characteristics - Periodic Law.
(d) Economic uses of the elements and their compounds and common processes of manufacture.
2. (a) Laws of Chemistry - Law of Definite and Multiple Proportions; Boyle's Law; Charles' Law, Gay-Lussac's Law of Volumes; Dulong and Petit's Law, Raoult's Law, Periodic Law;
(b) Theories - Avogadro's Hypothesis; Molecular Theory; Atomic Theory; Ionization; Electrons (note first appearance);
(c) Acids, Bases, Salts; Neutralization - Normal Solutions;
(d) Valence; Chemical Formulae; Chemical Equations; Calculations.

B. ORGANIC CHEMISTRY

Carbohydrides; Carbohydrates; Alcohols; Acids; Esters; Fats; Soaps; Explosives; Poisonous Gases.

C. QUALITATIVE ANALYSIS

Analysis of simple salts for acid radicals and bases.

COURSE OUTLINE FOR PHYSICS I, 1925*

I. MOLECULAR THEORY OF THE COMPOSITION OF MATTER

- 1) Molecular forces: cohesion, adhesion, surface tension, capillarity.
- 2) Molecular motions explaining phenomena of heat, expansion, gas pressure, diffusion and osmosis.

II. HEAT

- 1) (a) Nature and sources of heat.
(b) Expansion of solids, liquids and gases when heated:
 - i) Solids - increase in length and diameter, coefficient of expansion, unequal expansion, practical applications.
 - ii) Liquids - Coefficient of expansion, practical applications - thermometer, its construction, graduation, Fahrenheit and Centigrade scales - maximum density of water, natural importance.
 - iii) Gases - Equal expansion of all gases, Charles' Law.
- 2) Heat transmission:
 - (a) Methods - conduction, convection, radiation.
 - (b) Practical applications - heating and ventilation systems in houses, large buildings, mines, hot air, hot water and steam systems.
- 3) Heat measurements: Calorie, B.T.U., Thermal capacity, specific heat, practical applications.
- 4) Changes of State:
 - (a) Solids to liquids, liquids to solids.
 - (1) Freezing and melting points - effect of pressure and of substances in solution - change of volume.
 - (2) Heat of fusion - heat required for solution, freezing mixtures, practical applications.
 - (b) Liquids to gases, gases to liquids:
 - (1) Evaporation - conditions affecting rate of evaporation, heat absorbed, dew point, humidity and vapor pressure.
 - (c) Boiling point - effect of pressure, altitude and substances in solution on boiling point - distillation.
 - (d) Practical applications - cooling by evaporation, artificial cooling, hydrometer.

*Taken from the Handbook for Secondary Schools, Alberta, Province of Alberta, Department of Education, 1925.

COURSE OUTLINE FOR PHYSICS I, 1925 (continued)

III. WAVE MOTION

- 1) Energy transmission - direct contact, conduction, convection currents, wave motion.
- 2) Wave motion - characteristics, modes of production of waves, transverse and longitudinal waves, wave lengths, amplitude, frequency, relation between velocity, wave length and frequency - reflection of waves, standing waves, modes and loops.
- 3) Energy transmitted by wave motion - sound, light, electricity, e.g. wireless telegraphy and radiophones - media of transmission.

IV. SOUND

- 1) Production, transmission, velocity, reflection, echo, relation of velocity to medium of transmission.
- 2) Intensity of sound, relation to density of medium, amplitude of vibration, distances of sounding body. Consonance and Resonance - principle involved in each case.
- 3) Musical tone - characteristics, intensity, pitch, quality and factors upon which each depends.
- 4) Musical instruments - production of musical tone, change of pitch and change of intensity, various stringed and wind instruments, phonograph.

V. LIGHT

- 1) (a) Nature of transmission of light - pinhole camera, shadows.
(b) Intensity of illumination, illuminating power, law of inverse squares, photometry, practical applications.
- 2) Reflection of Light:
 - (a) Plane mirrors, laws of reflection, position and characteristics of images in inclined and parallel mirrors.
 - (b) Curved mirrors, e.g. convex, concave and parabolic: principal axis, radius of curvature, principal focus, real and virtual images, relative position and magnitude of object and image; practical uses.
- 3) Refraction of Light:
 - (a) Nature and cause of refraction; laws of refraction; index of refraction; refraction phenomena - plate glass, prisms, lens; total reflection.
 - (b) Lenses - concave and convex - principal focus, focal length, power, conjugate foci, images.
 - (c) Applications, Luxfer prisms, magnifying glasses, spectacles, camera, projection lantern, microscope.

COURSE OUTLINE FOR PHYSICS I, 1925 (continued)

4) Color:

- (a) Production of the spectrum, complementary colors, rainbow.
- (b) Color of objects, mixing of paints.

N.B. The course in light should be mainly experimental drawings representing images with plane and curved mirrors and lenses being omitted.

VI. ELECTRICITY AND MAGNETISM

1) Magnetism

- (a) Natural and artificial magnets; magnetic substances; polarity, Law of Attraction and Repulsion; induction, field of force, magnetic permeability, shielding.
- (b) Earth's magnetism - Demonstration of Earth's polarity and inductive action; declination and inclination; compass.

2) Current Electricity

- (a) Voltaic cell - construction, source of energy, local action, polarization, detection of current; a few common cells, construction, use, methods of preventing polarization and local action.
- (b) Electric units - ampere, volt, ohm, Ohm's Law; grouping of cells.

3) Chemical and Magnetic Effects of the Electric Current

- (a) Chemical - electrolysis of water, electro-plating.
- (b) Magnetic:
 - i. Magnetic field about a conductor; electro-magnetic function of helix and core; conditions determining strength of electromagnets.
 - ii. Practical applications of electro-magnet - electric bell, telegraph instruments, lifting magnets, galvanometers.

4) The Induced Current

Conditions for production of induced currents, direction of induced currents - Lenz' Law, alternating currents; easy illustrations.

COURSE OUTLINE FOR PHYSICS II, 1925*

I. MEASUREMENTS

Units of time, mass, length, area, volume, etc., and methods of measuring these quantities.

II. MOTION

- (a) Definition - displacement - velocity - parallelogram of velocities - resolution of displacements.
- (b) Acceleration - uniform acceleration, acceleration due to gravity.
- (c) Momentum - relation of momentum to mass and velocity - change of momentum - relation to force and time - Newton's Second Law of Motion - transference and conservation of momentum.

III. FORCE

- (a) Gravitation and absolute units of force - mass and weight - comparison of masses.
- (b) Inertia - Newton's First Law.
- (c) Action and Reaction - Newton's Third Law.
- (d) Centrifugal and Centripetal forces, partical applications, e.g. centrifuge, Babcock's Milk Tester, Cream Separator.
- (e) Composition and Resolution of forces - parallelogram of forces, triangle of forces.
- (f) Moment of a force - resultant of parallel forces - couple - equilibrium of a rigid body.
- (g) Friction - sliding and rolling friction, coefficient of friction - laws of friction.
- (h) Centre of gravity - condition of equilibrium - three states of equilibrium.
- (i) Gravitation - principle of universal gravitation.

IV. ENERGY

- (a) Units of energy and power including heat, electrical and mechanical units.
- (b) Law of conservation of energy - transformation of energy and relation of energy and power units, heat, electrical and mechanical.
- (c) Power development and transmission - practical applications - water power and water wheels, turbines, steam engines, steam turbines, gasoline engines, wind mills - transformation of electrical energy, transmission and use of electrical energy.

*Taken from the Handbook for Secondary Schools, Alberta, Province of Alberta, Department of Education, 1925.

COURSE OUTLINE FOR PHYSICS II, 1925 (continued)

V. MACHINES

Levers, pulley, wheel and axle, inclined plane, wedge, screw, differential pulley, differential wheel and axle, automobile transmission.

MECHANICS OF FLUIDS

I. PRESSURE OF FLUIDS

- (a) Pressure of fluids at rest - pressure proportional to depth and specific gravity of liquid - pressure independent of shape of containing vessel - pressure at a point in a liquid equal in all directions - pressure gauge - calculation of pressure on horizontal vertical and inclined surfaces.
- (b) Transmission of pressure - pressure transmitted equally and undiminished in all directions and at right angles to surfaces.
- (c) Buoyancy - Archimedes' Principle - density and specific gravity, definition of terms and methods of determining specific gravity of solids and liquids.
- (d) Pressure on surfaces of water currents and winds due to their rate of flow.
- (e) Pressure of air - Torricelli's experiment - cistern barometer, aneroid barometer - determination of heights by barometer - buoyancy of gases.

II. SURFACE TENSION

Surface tension - laws of capillarity - practical applications.

III. THE FLOW OF LIQUIDS

Torricelli's Law - rate of flow of a liquid - energy of a liquid in motion - Bernoulli's Principle - Venturi water meter - practical applications - jet pump, Bunsen's filter pump, atomizer.

IV. KINETIC THEORY OF GASES

Explaining Boyle's Law, Charles' Law, rate of diffusion of gases through porous walls, expansive pressure of gases - calculation of rate of motion of molecules of gases.

V. MACHINES

Construction and operation and principles applied. Lift pump, force pump, hydraulic press, siphon, Geryk or oil air pump, mercury air pump, condensation vacuum pump, air compressors, air brakes, pneumatic caisson, pneumatic hammer and drill.

THE GRADE IX COURSE IN GENERAL SCIENCE I - 1931*

PART ONE - MEASUREMENT

- I Measurement
- II Exercises in Measurement

PART TWO - AIR

- III The Earth's Atmosphere
- IV The Physical Properties of Air
- V How Man Uses the Physical Properties of Air
- VI Measuring the Pressure of the Atmosphere
- VII Temperature Changes in the Atmosphere and the Air Movements Caused by Them
- VIII The Composition of the Atmosphere
- IX Oxygen in Relation to Plants and Animals
- X Ventilation
- XI Natural Importance of Nitrogen and Carbon Dioxide
- XII Natural Importance of Water Vapour and Dust in the Atmosphere

PART THREE - WATER

- XIII Importance, Forms, and Properties of Water
- XIV Man and the Properties of Water
- XV The Composition and Chemical Properties of Water
- XVI Relation of Water to Plants
- XVII Drinking Water
- XVIII Water in Relation to Industry and Commerce

PART FOUR - LIFE

- XIX The Nature of Life and the Relation of Plants and Animals
- XX Plant Life
- XXI Processes by Which Plant Food is Transformed into Reserve Food and Stored in the Plant
- XXII Production and Dissemination of Seeds
- XXIII Plant Distribution
- XXIV Animal Adaptations
- XXV Animal Adaptations (continued)

PART FIVE - ENERGY

- XXVI The Nature of Energy, Its Manifestations and Transformations
- XXVII Energy in Relation to Man
- XXVIII Machines and the Principle of Work

*Taken from Hilton, M. J., A Book of General Science.
(Toronto: The Macmillan Company, 1931), pp. vii - viii.

THE GRADE IX COURSE IN GENERAL SCIENCE I (continued)

PART FIVE - ENERGY

- XXVI The Nature of Energy, Its manifestations and Transformations
- XXVII Energy in Relation to Man
- XXVIII Machines and the Principle of Work

PART SIX - THE EARTH'S CRUST

- XXIX Materials of the Earth's Crust - Rocks and Minerals
- XXX Mineral Deposits

PART SEVEN - THE SOLAR SYSTEM

- XXXI Suns and Stars
- XXXII Earth and Moon

APPENDIX D

OUTLINE OF CONTENTS OF PRESCRIBED TEXTBOOKS

Introduction to Physical Science, by A. P. Gage, Ph.D.

List of Chapters and Lessons, Lessons in Elementary Physics,
1895 (by Balfour Stewart)

List of Chapters from Waddell's School Chemistry

List of Chapters from Mills' Chemistry for Schools.

List of Chapters from Remsen's Chemistry, Briefer Course

List of Chapters from New Practical Chemistry, Book One (by
N. H. Black and J. B. Conant)

List of Chapters from Elementary Chemistry, Book II (by W.
Littler)

List of Chapters from Elements of Physics for Canadian Schools
(by F. W. Merchant and G. A. Chant)

Outline of the Prescribed Course in Physics I - 1944, according
to Chapters from the Prescribed Text (Modern Physics,
by C. E. Dull)

Outline of the Prescribed Course in Physics 2 - 1944, according
to Chapters from the Prescribed Text (Modern Physics,
by C. E. Dull)

Outline of the Course in Chemistry 2 - 1944, According to
Chapters from the Prescribed Text (New World of Chemis-
try by Bernard Jaffe)

INTRODUCTION TO PHYSICAL SCIENCE

by A. P. Gage, Ph.D.

(W. J. Gage & Co., Toronto, 1892)

CHAPTER I MATTER, ENERGY, MOTION AND FORCE

- Section I Matter and Energy
 - II Relative Motion and Relative Rest
 - III Force
 - IV Attraction of Gravitation
 - V Molecular Forces

CHAPTER II DYNAMICS OF FLUIDS

- Section I Pressure in Fluids
 - II Measurement of Atmospheric Pressure, Barometers
 - III Properties of Gases, Boyle's or Mariotte's Law
 - IV Instruments Used for Rarefying and Condensing Air
 - V Apparatus for Raising Liquids
 - VI Transmission of External Pressure (Liquids)
 - VII Pressure Exerted by a Liquid (Pascal's Vases)
 - VIII The Siphon
 - IX Buoyant Force of Fluids
 - X Density and Specific Gravity
 - XI Experimental Methods of Determining Density and Specific Gravity

CHAPTER III GENERAL DYNAMICS

- Section I Momentum and its Relation to Force
 - II First Law of Motion
 - III Second Law of Motion
 - IV Composition and Resolution of Forces
 - V Third Law of Motion
 - VI Applications of Three Laws of Motion - Center of Gravity
 - VII Applications of Newton's Laws - continued - Effect of Constant Force on a Body Free to Move - Falling Bodies
 - VIII Applications of Newton's Laws - continued - Curvilinear Motion
 - IX Applications of Newton's Laws - continued - The Pendulum

CHAPTER IV WORK AND ENERGY

- Section I Method of Estimating Work and Energy
 - II The Absolute or C.G.S. System of Measurement
 - III Machines - Uses of; General Law of

INTRODUCTION TO PHYSICAL SCIENCE (continued)

CHAPTER V MOLECULAR ENERGY - HEAT

- Section I What Heat Is; Some Sources of Heat
- II Temperature - Methods of Equalization
- III Effects of Heat - Expansion
- IV Thermometry
- V Liquefaction; Vaporization; Distillation; Evaporation
- VI Heat Convertible into Potential Energy and Vice Versa
- VII Thermodynamics
- VIII Steam-Engine

CHAPTER VI ELECTRICITY AND MAGNETISM

- Section I Introductory Experiments
- II Potential and Electromotive Force
- III Batteries
- IV Some Effects Produced by an Electric Current
- V Electrical Measurements
- VI C.G.S. Magnetic and Electromagnetic Units
- VII Galvanometers
- VIII Resistance and Conductors
- IX E.M.F. of Different Batteries, Ohm's Law
- X Divided Circuits - Methods of Combining Voltaic Cells
- XI Transformation of Electric Energy into Heat
- XII Magnets and Magnetism
- XIII Current and Magnetic Electric Induction
- XIV Dynamo Electric Machines
- XV Useful Applications of Electric Energy - Electric Light
- XVI Useful Applications of Electric Energy - Telegraphy
- XVII Useful Applications of Electric Energy - Telephony
- XIX Thermo-Electric Currents
- XX Static Electricity
- XXI Electrical Machines, Condensers, etc.

CHAPTER VII SOUND

- Section I Study of Vibrations and Waves
- II Sound Waves
- III Velocity of Sound Waves (Dependent on Elasticity and Density of Medium)
- IV Reflection of Sound Waves - Echoes
- V Intensity of Sound
- VI Reinforcement of Sound Waves and Interference of Sound Waves
- VII Pitch of Musical Sounds
- VIII Vibration of Strings

INTRODUCTION TO PHYSICAL SCIENCE (continued)

CHAPTER VII (continued)

- Section IX Overtones and Harmonies
- X Quality of Sound
- XI Composition of Sonorous Vibrations, and the Resultant Wave Forms
- XII Musical Instruments
- XIII Some Sound Wave Receivers (The Phonograph; the Ear)

CHAPTER VIII RADIANT ENERGY, ETHER-WAVES - LIGHT

- Section I Introduction; Solar Energy; Ether, the Medium of Motion; Undulatory Theory
- II Photometry, Visual Angle, etc.
- III Reflection of Light-Waves
- IV Refraction
- V Double Refraction
- VI Prisms and Lenses
- VII Prismatic Analysis of Light-Waves - Spectra
- VIII Color
- IX Thermal Effects of Radiation
- X Some Optical Instruments

LIST OF CHAPTERS AND LESSONS
LESSONS IN ELEMENTARY PHYSICS, 1895*

INTRODUCTION

CHAPTER I LAWS OF MOTION

- Lesson 1 Determination of Units.
- Lesson 2 First Law of Motion.
- Lesson 3 Second Law, First Statement,
Action of a Single Force on a Moving Body
- Lesson 4 Second Law Continued:
Action of Two or More Forces
- Lesson 5 Forces Statically Considered.
- Lesson 6 Laws of Motion.

CHAPTER II THE FORCES OF NATURE

- Lesson 7 Universal Gravitation.
- Lesson 8 Atwood's Machine
- Lesson 9 Centre of Gravity, etc.
- Lesson 10 Forces Exhibited in Solids.
- Lesson 11 Forces Exhibited in Liquids.
- Lesson 12 Forces Exhibited in Gases.

CHAPTER III ENERGY

- Lesson 13 Definition of Energy.
- Lesson 14 Varieties of Energy.
- Lesson 15 Conservation of Energy.

CHAPTER IV MOLAR ENERGY AND ITS TRANSMUTATIONS

- Lesson 16 Varieties of Molar Energy

CHAPTER V SOUND

- Lesson 17 Undulations.
- Lesson 18 Transmission of Sound.
- Lesson 19 Vibration of Sounding Bodies.

CHAPTER VI HEAT

- Lesson 20 Temperature.
- Lesson 21 Expansion of Solids and Liquids Through Heat.
- Lesson 22 Expansion of Gases. Practical Application.
- Lesson 23 Change of State and Other Effects of Heat.
- Lesson 24 Conduction and Convection.
- Lesson 25 Specific and Latent Heat.
- Lesson 26 On the Relation Between Heat and Mechanical
Energy.

*Stewart, Balfour, Lessons in Elementary Physics, New and Enlarged Edition. (London: The Macmillan Company, 1895).

CHAPTER VII RADIANT ENERGY

- Lesson 27 Preliminary.
- Lesson 28 Reflection of Light.
- Lesson 29 Refraction of Light.
- Lesson 30 Lenses and Other Optical Instruments.
- Lesson 31 Dispersion of Light by the Prism.
- Lesson 32 Thermo-Pile.
- Lesson 33 Radiation and Absorption.
- Lesson 34 On the Nature of Radiant Energy.
- Lesson 35 Polarisation of Light. Connection Between
Radiant Energy and other Forms of Energy.

CHAPTER VIII ELECTRICAL SEPARATION

- Lesson 36 Development of Electricity.
- Lesson 37 Electrostatic Induction.
- Lesson 38 Measurement of Electricity.
- Lesson 39 Electrical Machines.
- Lesson 40 Condensers of Electricity.
- Lesson 41 Atmospheric Electricity, etc.

CHAPTER IX MAGNETISM

- Lesson 42 Fundamental Facts.
- Lesson 43 Terrestrial Magnetism.
- Lesson 44 Magnetic Measurements.

CHAPTER X ELECTRICITY IN MOTION

- Lesson 45 Voltaic Batteries.
- Lesson 46 Effect of Electric Current Upon a Magnet.
- Lesson 47 Electro Dynamics and Electromagnetism.
- Lesson 48 Electro-Magnetic Induction.
- Lesson 49 Distribution and Movement of Electricity in
a Voltaic Battery.
- Lesson 50 Effects of the Electric Current.
- Lesson 51 Applications of Electricity.

CHAPTER XI

- Lesson 52 Energy of Separation
Concluding Remarks

RECAPITULATION

LIST OF CHAPTERS FROM WADDELL'S SCHOOL CHEMISTRY*

CHAPTER

- I WATER
 - II HYDROGEN
 - III OXYGEN
 - IV NITROGEN (AMMONIA)
 - V CARBON DIOXIDE AND MONOXIDE
 - VI ACTION OF HYDROCHLORIC ACID ON ALKALIS
 - VII LAWS OF CHEMICAL COMBINATION AND THE ATOMIC THEORY
 - VIII COMMON SALT AND SOME SIMILAR COMPOUNDS
 - IX HYDROCHLORIC ACID
 - X THE HALOGENS
 - XI NITRIC ACID AND THE OXIDES OF NITROGEN
 - XII SULPHUR
 - XIII THE PHOSPHORUS GROUP OF ELEMENTS
 - XIV CARBON (ACETYLENE)
 - XV METALS
 - XVI THE ALKALI METALS
 - XVII THE METALS OF THE ALKALINE EARTHS
 - XVIII THE ZINC GROUP OF METALS
 - XIX THE IRON GROUP OF METALS
 - XX METALS OF THE LEAD AND OF THE COPPER GROUP
- - - - -
- APPENDIX A: THE THERMOMETER
 - **APPENDIX B: THE LAW OF RECIPROCAL PROPORTIONS OR RECIPROCAL RATIOS
 - APPENDIX C: RE THE BEST VOLUME TO TAKE AS STANDARD FOR GASES (One Volume of hydrogen at S.T.P. (22.4l))
 - **APPENDIX D: ELECTROLYTIC DISSOCIATION

*Waddell, J., A School Chemistry, Second Edition. (New York: The Macmillan Company).

**Not included previous to the 1913 edition.

LIST OF CHAPTERS FROM MILLS' SCHOOL CHEMISTRY*

CHAPTER

- I REACTIONS - SUBSTANCES
- II OXYGEN
- III CONSERVATION OF MASS
- IV OZONE
- V GAS LAWS
- VI HYDROGEN
- VII WATER
- VIII HYDROGEN PEROXIDE
- IX CARBON AND ITS COMPOUNDS
- X REVIEW OF MECHANICAL MIXTURES, CHEMICAL INDIVIDUALS AND SOLUTIONS
- XI LAW OF REACTING WEIGHTS
- XII CHLORINE AND ITS COMPOUNDS (VALENCY)
- XIII AIR
- XIV NITROGEN AND ITS COMPOUNDS
- XV SULPHUR AND ITS COMPOUNDS
- XVI STRENGTH OF ACIDS AND BASES
- APPENDIX: THE ATOMIC HYPOTHESIS

*Mills, G. K., Chemistry for Schools. (Toronto: W. J. Gage and Company, 1906).

LIST OF CHAPTERS FROM REMSEN'S CHEMISTRY, BRIEFER COURSE*
CHAPTER

- I CHEMICAL ACTION - ELEMENTS - COMPOUNDS - HOW TO STUDY CHEMISTRY
- II A STUDY OF THE ELEMENT OXYGEN
- III HYDROGEN
- IV COMBINATION OF HYDROGEN AND OXYGEN - WATER
- V LAWS OF CHEMICAL COMBINATIONS - COMBINING WEIGHTS - ATOMIC WEIGHTS - CHEMICAL EQUATIONS
- VI STUDY OF THE REACTIONS EMPLOYED IN THE PREPARATION OF OXYGEN AND OF HYDROGEN, AND THE STUDY OF WATER
- VII CHLORINE AND ITS COMPOUNDS WITH HYDROGEN AND OXYGEN
- VIII ELECTROLYSIS - ACIDS - BASES - NEUTRALIZATION - SALTS - ELECTROLYTIC DISSOCIATION
- IX NITROGEN - AIR
- X COMPOUNDS OF NITROGEN WITH HYDROGEN AND OXYGEN
- XI AVOGADRO'S HYPOTHESIS - MOLECULAR WEIGHTS - MOLECULAR FORMULAS - VALENCE
- XII CARBON
- XIII SOME OF THE SIMPLER COMPOUNDS OF CARBON
- XIV CLASSIFICATION OF THE ELEMENTS - PERIODIC LAW
- XV THE CHLORINE GROUP
- XVI THE SULPHUR GROUP
- XVII THE NITROGEN GROUP
- XVIII THE CARBON GROUP
- XIX BASE-FORMING ELEMENTS - GENERAL CONSIDERATIONS
- XX THE POTASSIUM GROUP
- XXI THE CALCIUM GROUP
- XXII THE MAGNESIUM GROUP
- XXIII THE COPPER GROUP
- XXIV THE ALUMINUM GROUP
- XXV THE LEAD GROUP
- XXVI THE IRON GROUP
- XXVII MANGANESE, CHROMIUM AND URANIUM
- XXVII** PALLADIUM, PLATINUM, GOLD
- XXIX OSMOTIC PRESSURE, EQUILIBRIUM, LAW OF MASS ACTION
- XXX SOME FAMILIAR COMPOUNDS OF CARBON
- XXXI OTHER COMPOUNDS OF CARBON
- XXXII QUALITATIVE ANALYSIS
- APPENDIX I MEASUREMENT OF GASES
- APPENDIX II FILTERING AND WASHING

*Remsen, Ira, Chemistry, Briefer Course. (New York: Henry Holt and Company, 1909).

**This chapter was mis-numbered in the book!

LIST OF CHAPTERS FROM NEW PRACTICAL CHEMISTRY, BOOK ONE*

CHAPTER

- I HISTORICAL INTRODUCTION, FIELD OF CHEMISTRY
 - II CHEMICAL AND PHYSICAL CHANGES
 - III ELEMENTS AND COMPOUNDS
 - IV OXYGEN, COMBUSTION AND OZONE
 - V HYDROGEN AND ITS USES
 - VI WATER AND ITS COMPOSITION, HYDROGEN PEROXIDE
Review Questions on Chapters I - VI
 - VII DALTON'S THEORY OF ATOMS AND MOLECULES
 - VIII SYMBOLS, FORMULAS AND VALENCE
 - IX CHEMICAL EQUATIONS AND COMPUTATIONS
Review Questions on Chapters VII - IX
 - X SODIUM CHLORIDE AND HYDROXIDE
 - XI CHLORINE AND HYDROGEN CHLORIDE
 - XII ACIDS, BASES AND SALTS
 - XIII IONS AND ELECTRONS
 - **XIV ATOMIC STRUCTURE AND VALENCE
Review Questions on Chapters X - XIV
 - XV SULFUR AND THE SULFIDES
 - XVI OXIDES OF SULFUR AND THE ACIDS
 - XVII CARBON AND ITS TWO OXIDES
 - XVIII MOLECULAR AND ATOMIC WEIGHTS
General Review Questions on Chapters I - XVIII
 - XIX NITROGEN AND ATMOSPHERIC GASES
 - XX AMMONIA AND AMMONIUM COMPOUNDS
 - XXI NITRIC ACID AND FIXATION OF NITROGEN
Review Questions on Chapters XIX - XXI
 - ***XXII NEW PERIODIC LAW
- APPENDIX
- Physical Principles in Regard to Gases
 - List of Books for Further Study
 - Industrial Chart
 - Solubility of Solids in Water
 - Solubility of Gases in Water
 - Pressure of Water Vapor
 - Densities of Important Gases
 - Some Common Substances, Chemical Names and Formulas
 - Scale of Hardness

*Black, N. H. and Conant, J. B., New Practical Chemistry, Book One, (Toronto: The Macmillan Company of Canada, 1937).

**Optional in Chemistry I

***Omitted in Chemistry I

LIST OF CHAPTERS FROM ELEMENTARY CHEMISTRY, BOOK II*

CHAPTER

	INTRODUCTION. THE USEFULNESS OF CHEMISTRY
I	IMPORTANT POINTS REVIEWED
II	REVERSIBLE REACTIONS
III	FREEZING POINT, BOILING POINT, AND MOLECULAR WEIGHT
IV	IONIZATION
V	THE HALOGEN FAMILY
VI	THE PERIODIC LAW
VII	THE NITROGEN-PHOSPHORUS FAMILY
VIII	COMPOUNDS OF SILICON AND BORON
IX	METALS AND ALLOYS
X	SODIUM AND ITS COMPOUNDS
XI	POTASSIUM
XII	SOME COMMERCIAL FERTILIZERS
XIII	CALCIUM, STRONTIUM, BARIUM
XIV	THE MAGNESIUM-ZINC FAMILY
XV	ALUMINUM
XVI	THE IRON FAMILY (Iron, Cobalt, Nickel)
XVII	COPPER AND SILVER
XVIII	TIN AND LEAD
XIX	GOLD AND PLATINUM
XX	MANGANESE AND CHROMIUM
XXI	SOME IMPORTANT CARBOHYDRIDES
XXII	NATURAL OIL, GAS AND TAR
XXIII	STARCH, SUGARS, AND CELLULOSE
XXIV	PAPER, RAYON, AND RUBBER
XXV	ALCOHOLS, ESTERS
XXVI	FOODS AND VITAMINS
XXVII	RADIUM
XXVIII	THE STRUCTURE OF THE ATOM
	CONCLUSION. WHAT OF THE FUTURE?

*Littler, W., Elementary Chemistry, Book II, Second Edition. (Toronto: Clarke, Irwin and Company, 1940).

ELEMENTARY CHEMISTRY, BOOK II (continued)

APPENDIX

SIMPLE QUALITATIVE ANALYSIS

TABLES OF SOLUBILITIES

ALLOYS

SOME IMPORTANT TEMPERATURES

PHYSICAL CONSTANTS OF SOME IMPORTANT ELEMENTS

BOILING POINTS

INDEX

ANSWERS TO NUMERICAL EXAMPLES

LIST OF THE COMMONER ELEMENTS AND THEIR ATOMIC WEIGHTS

Note: The Introduction; Complex Silicates, pages 97 - 101; Chapter XII, Chromium, pages 234 - 236; Chapters XXII, XXIV, XXVI and the Conclusion of the authorized text-book may be treated as required reading, and not necessarily be dealt with in class.
(Program of Studies for the High School, Bulletin IV, 1939).

LIST OF CHAPTERS FROM ELEMENTS OF PHYSICS FOR
CANADIAN SCHOOLS *

CHAPTER

PART I INTRODUCTION

- I INTRODUCTORY IDEAS
- II MEASUREMENT - THE YARD, THE METRE
- III MASS AND ITS MEASUREMENT; TIME
- IV MEANING OF SPECIFIC GRAVITY

PART II MECHANICS OF FLUIDS

- V PRESSURE OF LIQUIDS
- VI LIQUIDS UNDER THEIR OWN WEIGHT
- VII BUOYANCY OF LIQUIDS
- VIII SPECIFIC GRAVITY
- IX PRESSURE OF THE AIR
- X MEASURING THE PRESSURE OF THE ATMOSPHERE
- XI EXPLORING THE ATMOSPHERE AND WEATHER FORECASTING
- XII BUOYANCY OF GASES; BOYLE'S LAW
- XIII AIR PUMPS AND AIR APPLIANCES
- XIV WATER PUMPS AND WATER POWER

PART III MECHANICS OF SOLIDS

- XV VELOCITY, ACCELERATION
- XVI COMPOSITION OF VELOCITIES; TRANSLATION AND ROTATION
- XVII INERTIA
- XVIII MOMENTUM OF A FORCE; RESULTANT OF FORCES
- XIX GRAVITATION
- XX WORK AND ENERGY
- XXI CENTRE OF GRAVITY
- XXII FRICTION
- XXIII MACHINES; LEVERS
- XXIV THE PULLEY
- XXV WHEEL AND AXLE; INCLINED PLANE

PART IV SOME PROPERTIES OF MATTER

- XXVI THE MOLECULAR THEORY OF MATTER
- XXVII THE MOTIONS AND THE NATURE OF THE MOLECULES
- XXVIII PHENOMENA OF SURFACE TENSION AND CAPILLARITY

PART V HEAT**

- XXIX SOURCES AND NATURE OF HEAT
- XXX EXPANSION THROUGH HEAT
- XXXI TEMPERATURE

*Merchant, F. W. and Chant, G. A. Elements of Physics for Canadian Schools, New Edition. (Toronto: The Copp Clark Co., 1937).

**These chapters constituted the Physics 2 course.

ELEMENTS OF PHYSICS FOR CANADIAN SCHOOLS (continued)

CHAPTER

- XXIII RATE OF EXPANSION; SOLIDS AND LIQUIDS
- XXXIII EXPANSION OF GASES--CHARLES' LAW
- XXXIV MEASUREMENT OF HEAT
- XXXV CALORIMETERS AND THEIR USE
- XXXVI CHANGE OF STATE - SOLID TO LIQUID
- XXXVII CHANGE OF STATE - LIQUID TO VAPOUR
- XXXVIII ARTIFICIAL REFRIGERATION
- XXXIX MOISTURE IN THE ATMOSPHERE
- XL TRANSFERENCE OF HEAT: CONDUCTION AND CONVECTION
- XLI APPLICATIONS OF CONVECTION; RADIATION
- XLII HEAT AND MECHANICAL MOTION
- PART VI SOUND
- XLIII PRODUCTION, PROPAGATION, VELOCITY OF SOUND
- XLIV SOUND: ITS TRANSMISSION; THE NATURE OF WAVES
- XLV SOUND WAVES: THEIR NATURE AND THEIR VELOCITY IN SOLIDS AND GASES
- XLII INTENSITY, PITCH
- XLVII FREQUENCY OF VIBRATION; MUSICAL SCALES
- XLVIII VIBRATIONS OF STRINGS
- XLIX VIBRATIONS OF AIR COLUMNS; ORGAN PIPES
- L VIBRATIONS OF PLATES AND RODS
- LI QUALITY, VIBRATING FLAMES, BEATS
- LII MUSICAL INSTRUMENTS; THE PHONOGRAPH
- PART VII LIGHT
- LIV ILLUMINATION
- LV PHOTOMETERS
- LVI REFLECTION OF LIGHT: PLANE MIRRORS
- LVII REFLECTION FROM CURVED MIRRORS: CONCAVE
- LVIII REFLECTION FROM CURVED MIRRORS (CONCLUDED)
- LIX REFRACTION
- LX REFRACTION THROUGH PLATES AND PRISMS
- LXI LENSES
- LXII DIVERGING LENSES; APPLICATIONS OF LENSES
- LXIII DISPERSION, COLOUR
- LXIV THE SPECTROSCOPE, THE RAINBOW
- LXV OPTICAL INSTRUMENTS
- PART VIII ELECTRICITY AND MAGNETISM**
- LXVI MAGNETS AND MAGNETIC SUBSTANCES
- LXVII LINES OF FORCE AND MAGNETIC SHIELDING
- LXVIII THE EARTH'S MAGNETISM
- LXIX ELECTRICAL ATTRACTION AND REPULSION, THE ELECTRON THEORY
- LXX ELECTRIFICATION BY INDUCTION

ELEMENTS OF PHYSICS FOR CANADIAN SCHOOLS (continued)

CHAPTER

- LXXI POTENTIAL, CONDENSERS, MACHINES
- LXXII THE ELECTRIC CURRENT
- LXXIII CHEMICAL EFFECTS OF THE ELECTRIC CURRENT
- LXXIV VOLTAIC CELLS; STORAGE CELLS
- LXXV ELECTRICAL UNITS: AMPERES, VOLTS, OHMS
- LXXVI MAGNETIC RELATIONS OF THE CURRENT
- LXXVIII PRACTICAL APPLICATIONS OF ELECTROMAGNETS
- LXXIX ELECTROMAGNETIC INDUCTION
- LXXX DYNAMOS AND MOTORS
- LXXXI TRANSFORMERS AND TELEPHONES
- LXXXII HEATING AND LIGHTING BY THE ELECTRIC CURRENT
- LXXXIII ELECTRICAL MEASUREMENTS
- PART IX OTHER FORMS OF RADIANT ENERGY**
- LXXXIV ULTRA VIOLET, INFRA RED, ELECTRIC WAVES
- LXXXV RADIO TRANSMISSION AND RECEPTION
- LXXXVI X-RAYS, PHOTOELECTRICITY, RADIOACTIVITY
- REVIEW PROBLEMS

OUTLINE OF THE PRESCRIBED COURSE IN PHYSICS I - 1944
ACCORDING TO CHAPTERS FROM THE PRESCRIBED TEXT*

CHAPTER

UNIT ONE: MATTER AND MECHANICS

- 1 MATTER AND ITS PROPERTIES
- 2 MECHANICS OF LIQUIDS
- 3 MECHANICS OF GASES

UNIT TWO: MOLECULAR PHYSICS

- 4 MOLECULES--THEIR BEHAVIOR

UNIT SIX: HEAT

- 9 HEAT--THERMOMETRY
- 10 HEAT--EXPANSION

UNIT SEVEN: SOUND

- 14 SOUND
- 15 SOUND--MUSIC

UNIT EIGHT: LIGHT

- 16 LIGHT
- 17 LIGHT--REFLECTION
- 18 LIGHT--REFRACTION
- 19 LIGHT--OPTICAL INSTRUMENTS
- 20 LIGHT--COLOR

*Dull, C. E., Modern Physics (New Edition). (Toronto: Clarke, Irwin and Company, 1945). First authorized as the prescribed textbook for Physics 1 in Alberta Schools in 1944.

OUTLINE OF THE PRESCRIBED COURSE IN PHYSICS 2 - 1944
ACCORDING TO CHAPTERS FROM THE PRESCRIBED TEXT*

CHAPTER

UNIT THREE: FORCE AND MOTION

5 FORCE

6 MOTION

UNIT FOUR: WORK - POWER - ENERGY

7 WORK - POWER - ENERGY

UNIT FIVE: MACHINES

8 MACHINES

UNIT SIX: HEAT

11 HEAT UNITS - CHANGE OF STATE

12 HEAT--HOW IT IS DISTRIBUTED

13 HEAT AND WORK

UNIT NINE: MAGNETISM AND STATIC ELECTRICITY

21 MAGNETISM

22 ELECTRICITY--STATIC OR FRICTIONAL

UNIT TEN: CURRENT ELECTRICITY

23 CURRENT ELECTRICITY - VOLTAIC CELLS

24 EFFECTS OF THE ELECTRIC CURRENT

25 MEASURING INSTRUMENTS

26 INDUCED CURRENTS

27 ELECTRO-MAGNETIC INDUCTION

UNIT ELEVEN: RADIO AND RADIATIONS

28 X-RAYS - RADIO - RADIO-ACTIVITY**

UNIT TWELVE: TRANSPORTATION**

29 THE AUTOMOBILE - THE AIRPLANE

*Dull, C. E., Modern Physics (New Edition). (Toronto: Clarke, Irwin Company, 1945). First authorized as the prescribed textbook for Physics 2 in Alberta schools in 1944.

**Not part of the prescribed course - Free reading for those who wished.

OUTLINE OF THE COURSE IN CHEMISTRY 2 - 1944
ACCORDING TO CHAPTERS FROM THE PRESCRIBED TEXT*

CHAPTER

- **6 FORMULAS: THE CHEMIST'S UNIVERSAL SHORTHAND
- **8 EQUATIONS: THE SHORTHAND OF CHEMISTRY
- **9 THE MATHEMATICS OF CHEMISTRY
- 10 CHLORINE AND THE HALOGEN FAMILY
- 11 ELECTRONS, PROTONS AND NEUTRONS
- 13 ACIDS: HYDROCHLORIC ACID, A TYPICAL ACID
- 14 BASES: SODIUM HYDROXIDE, A TYPICAL BASE
- 16 IONS, AND THE IMPORTANCE OF IONIZATION
- 25 METALS AND THEIR RELATIVE CHEMICAL ACTIVITY
- 26 ALUMINUM: LIGHTEST OF THE COMMON METALS
- 27 IRON AND STEEL
- 28 COPPER: THE NERVES OF THE MACHINE AGE
- 29 SOME OTHER METALS AND THEIR USES
- 30 SOME FERTILIZERS AND SALTS OF SODIUM
- 31 SOME COMMON COMPOUNDS OF CALCIUM
- 32 SOME SPECIAL COMPOUNDS OF IRON
- 33 THE CHEMISTRY OF GLASS AND OTHER SILICATES
- 34 PETROLEUM AND OTHER HYDROCARBONS
- 35 ALCOHOL, VINEGAR, SOAP, AND SOME OTHER COMMON ORGANIC COMPOUNDS
- 36 FOODS, VITAMINS, HORMONES, AND CHEMOTHERAPY

*Jaffe, Bernard, New World of Chemistry. (New York: Silver Burdett Company, 1940). Adopted as the authorized textbook for Chemistry 2 by the Province of Alberta in 1944.

**These chapters did not constitute part of the regular Chemistry 2 course, but were suggested as useful material for review.

APPENDIX E
THE ATOMIC HYPOTHESIS

THE ATOMIC HYPOTHESIS*

When new and striking phenomena are first discovered, we often try to connect them together in the form of a mental picture by assuming some imaginary cause for the existence of the facts. For example, a ruddy glow above the horizon may at once suggest the mental picture of a burning house, and this assumption would afford a possible explanation of the light in the sky. Having made such an assumption, we are apt to think that we have "explained" the facts. We may draw conclusions as to the location of the building from the position of the light, and as to its size from the intensity of the glow. Absence of steam and smoke may be even taken as "proof" that the fire brigade has not yet arrived on the scene. On hearing the next day that the same phenomenon had been observed all over the country, we give up our mental picture of the burning house and content ourselves by saying that we had seen a rather unusual type of the Aurora Borealis.

Such mental pictures have, from time to time, been made in science. One of these, the atomic hypothesis, has had such a great influence on the past history and present nomenclature of chemistry that a short account of it may not be out of place. In order to "explain" the facts expressed in this book by the "law of reacting weights" Dalton, in 1803, made the assumption that matter consisted of small indivisible particles--the atoms--which in compound substances were combined together in small groups to form compound particles. By his further assumption that the atom of each substance had a small but constant weight, proportional to the combining weight, the facts of the law of reacting weights were thus "explained". According to this hypothesis carbon dioxide, for example, was assumed to consist of atoms, each containing one atom of carbon and two atoms of oxygen, while the atoms of carbon monoxide were supposed to contain one atom of carbon and one atom of oxygen each. Soon after this, chemical symbols were introduced; the symbol C, for example, stood for an atom of carbon, the symbol O for an atom of oxygen, etc. Thus, a symbol that is now employed to represent a definite number of grams of a particular substance, without reference to any hypothesis, was originally introduced to indicate the hypothetical atom of that substance.

From time to time, as new facts were discovered, attempts were made to "explain" these also, by modifying and extending the atomic hypothesis. The relation between the

* Mills, G.K., Chemistry for Schools. (Toronto: W. J. Gage and Company, 1906), p. 217.

volumes and reacting weights of gases led to the introduction of the hypothetical "molecule" and Avogadro's Hypothesis; and the pressure and temperature laws of gases were accounted for by the idea that these molecules were flying about with great rapidity. Again, just as the assumption of the burning house necessitated further assumptions as to its locality and size so also the development of the molecular hypothesis led to a determination of the size of the molecules.

Later still, certain phenomena observed in connection with aqueous solutions necessitated an even more complicated modification, namely the assumption that some molecules break up into parts endowed with electrical charges and called ions; while quite recently, owing to new discoveries in radio-activity which do not appear to fit in with the idea of the indivisibility of the atom, it has been assumed that the atoms themselves are capable of subdivision into a large number of smaller particles, to which the name electrons has been given.

At the present day, now that the laws governing the fundamental facts are found to be so simple and general, there is a tendency among chemists to abandon these cumbrous hypotheses, not only on account of the greater simplicity of the facts themselves, but also because it is now recognized that such hypotheses, although of great service in the past, have often led to unclear expression of the facts and one-sided development of the science. Just as for instance the burning house hypothesis may have prevented some people from studying a rare specimen of the Aurora, so also the atomic hypothesis is responsible for the imperfect study or total neglect of certain classes of phenomena which did not fit well with this explanation.

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